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WAS THIS THE FIRST FORM OF LIFE ON THE GLOBE?

Blue-green algae (Nostocaceae) such as are shown above, about 800 times natural size, are little different from bacteria in structure. They can live in hot springs and get their food exclusively from minerals. Euler suggests that they represent the earliest living thing in the world; if so, their spores must have been brought here from some other planet, propelled by waves of light. Unless they came from our own solar system, they must have travelled for at least 9,000 years before reaching the earth. Photomicrograph by John Howard Paine, from a preparation by H. L. Shantz. (Frontispiece.)

See "A Hit-or-Miss Universe," p. 320.

FEEBLE-MINDED IN OHIO

Survey of One County Shows That One Per Cent of Population is Mentally Defective—One Large Clan is Found to Descend From Marriage of an Immigrant With an Indian Squaw, Shortly Before Revolutionary War—Few of the Feebleminded are Properly Cared For

MINA A. SESSIONS
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ON MARCH 1, 1916, a survey of a rural county in Ohio was begun by the Bureau of Juvenile Research, to discover the extent and social significance of feeble-mindedness in that particular part of the state. The county chosen as the subject of the survey is situated in what is known as the hill section bordering the Ohio River, and on July 1, 1916, had an estimated population of 54,389. There are but two cities in the county, each of which has a population of between six and seven thousand. Along the bottom lands of the streams there is good farm land but because of its rough surface the larger part of the county is not suitable for agricultural purposes. Coal mining is the principal industry of the county.

The field work was done and a detailed report of findings has been prepared by the writer. She worked in the county studied from March 1 to December 20, 1916 and sought information in each township, first of all from the public schools, and then from the physicians and township trustees. The county institutions were visited and the county and city officials, the one district nurse, the one social worker, and many private citizens were interviewed. When cases of feeble-mindedness were discovered in the schools or reported from other sources, their homes were visited and information obtained concerning their personal and heredity histories. This procedure frequently led to the discovery of other feeble-minded persons who were in turn followed to their homes.

In general no formal intelligence tests were given, but the suspected cases were judged on a sociological basis with possession of ability or inability to maintain existence accepted as the essential difference between the normal and the feeble-minded person. The definitions of the English Royal Commission of 1904 were adopted as the standard. It was recognized that the environment in which many of the inhabitants of the county lived was a simple one, and for that reason a lower degree of mentality was sufficient to maintain a satisfactory existence than would have been the case in a more complicated environment.

In the various state institutions there were, on March first, two hundred and fifty-three persons from this county of whom forty-one were known to be feeble-minded. Only twenty, or less than half, of these were in the Institution for the Feeble-minded. Four were in one of the State Hospitals and the remaining seventeen, most of whom had been given formal intelligence tests, were in penal or correctional institutions.

In the County Infirmary there were found sixty-seven inmates. Of these, thirty-two individuals, or 47.7% of the total Infirmary population, were dependent on the county because their mentality was so low that they were unable to maintain themselves independently in the community at large. Eleven individuals, or 16.4%, were there because they had so broken down their physical and mental health by the excessive use of alcohol that they were no longer able to make their own way in the world at large. It is probable that some at least of these alcoholics could also be classed as feeble-minded since

A HOME OF THE HICKORIES

To this shanty in an Ohio city, an elderly man of the Hickory family, a great clan of defectives in rural Ohio, brought his girl-bride, together with his two grown sons by a former marriage. The shanty is 6 by 10 feet in size and contained a bed, table and stove. It was conveniently located at a distance of 100 feet from the city dump, where the family secured its food. The oldest son has been in the county infirmary and two younger children are in an institution. The whole family is feebleminded. The attention of the city authorities was called to this establishment when one of the sons was accidentally shot; the family was then forced to leave, but was afterward reunited. Such a family is incapable of protecting either itself or its neighbors, and should be cared for by the State. (Fig. 1.)

their inability to keep from becoming alcoholics may have been due to mental defect. Only twenty-four individuals, or 35.8%, were dependent because of some infirmity due to old age or illness.

RESULTS OF TESTS

Formal intelligence tests were made of the children in the County Children's Home and of the one hundred and one children in the Home at that time ten, or 9.9%, were feeble-minded. When this is compared with the percentage of feeble-minded children in the public schools of the county, it is seen that there is proportionately five times as much feeble-mindedness among the dependent children in the Children's Home as among the public school children.

Two hundred and ninety-seven teachers in one hundred and seventy-two separate school buildings were visited, or practically every grade teacher in the county. Of 8,930 school children enrolled, one hundred and sixty-four, or 1.8% of the enrollment, were found to be feeble-minded. In the urban schools, 0.8% of the children enrolled were feebleminded while in the rural districts 2.1% were feeble-minded. Or, in other words, the proportion of feeble-minded school children in the country districts was two and one-half times greater than it was in the cities.

A special study was made of two

THE HOUSE IN THE HOLLOW

In this log and pole cabin, built by a feebleminded Hickory man and his two sons, thirteen persons lived, all sleeping in a single room without any windows. A double bed, a single bed and a trundle bed were all the sleeping accommodations available. Members of a family like this, which is characterized by hereditary feeblemindedness and constant dependency, are not useful citizens, yet they are increasing in number every year, under the present regime of public indifference and careless charity. (Fig. 2.)

rural schools where a large number of feeble-minded were found. Every child in the two schools was given an intelligence test in order to verify the judgment of the field-worker. There were thirteen children in the first district school, of whom six, or 46%, were feeble-minded; two, or 15%, were borderline; and five, or 38%, were of normal intelligence. The six feeble-minded children included two brothers and two cousins, while the two borderline cases were sisters of one of the cousins. The district in which this school was situated was an old mining village where the mine had been abandoned and the more industrious part of the population had moved to a region affording better industrial advantages.

The second district school studied had thirty-one children enrolled. Of these, thirteen, or 42%, were feeble-minded; eight, or 26%, were borderline; and ten, or 32%, were of normal intelligence. This district was a rural community where most of the inhabitants owned small pieces of land and worked in the mines. The homes were situated along a creek between two high ridges. There were twelve family names in the school of thirty-one children. Nine children, only one of whom was feeble-minded, belonged to five different families and were in no way connected with other families in the valley. The remaining twenty-two children had seven family names, each one of which stood for a defective strain. Members of five of these families had married back and forth freely.

A CHIEFTAIN OF THE HICKORY CLAN

This is "Young Hank," otherwise known as "Sore-Eyed Hank." He is the eldest son and heir of that Hank Hickory who, with his wife and seven children, applied for admission to the County Infirmary when it was first opened. For generation after generation, his family has been the chief patron of all county charities. "Young Hank" married his cousin and duplicated his father's record by becoming the father of seven children, three of whom (all feeble-minded) are now living. The number of his grandchildren and great grandchildren is increasing every year, but the total cannot be learned from him, for he is mentally incapable even of counting the number of his own children. He is about 70 years of age and has never done any work except to make baskets. He has lived a wandering life, largely dependent on charity. (Fig. 3.)

A TYPICAL HICKORY RESIDENCE

When Elliott Hickory married, an aunt furnished land on which he built the shanty shown above. He got it up as far as the roof and then quit work, owing to lack of funds and inclination. After suffering the chagrin of seeing her daughter live in a roofless house for some time, Elliott's mother-in-law finally took in washing and secured enough money to buy tarred paper for a roof. She sent Elliott into town to purchase this, but he returned with a jag instead of with tarred paper. The mother-in-law thereupon raised another roofing fund, and spent it herself. But after the house was roofed, Elliott found it uncongenial, and has spent nearly all his time visiting various relatives, taking his wife with him. He is distinctly feeble-minded, and in the present ignorance of public opinion, this fact probably will ensure his leaving a large posterity to perpetuate his name and mental traits. (Fig. 4.)

There were found at large in the county, including school children, four hundred and ninety-four feeble-minded persons, which is equivalent to 0.9%, or nine to every thousand of the population. Twenty-one of these were idiots, one hundred and twenty-six were imbeciles, and the remaining three hundred and forty-seven were morons. Cards with short social and heredity histories for each one of them are on file at the office of the Bureau of Juvenile Research, together with four hundred and ninety-six other cards with similar information on the inmates of the county institutions and such anti-social persons or probable cases of feeble-mindedness as were brought to the attention of the field worker.

Of the four hundred and ninety-four feeble-minded persons at large, four hundred and fifty-seven were born in Ohio and three hundred and seventy-one of these, or 75% of the total, were born in the county in which they are now living. The great majority of cases were descendants of pioneer stock which came from Pennsylvania, New York, and the New England States. But two or 0.2% of the feeble-minded persons at large were born in other countries, while according to the last census, 5.3% of the population of the county was foreign born. Eighteen others, or 3.6% of the feeble-minded persons, were of foreign or mixed parentage, while at the time of the 1910 census, 9.2% of the population of the county were native born of foreign or mixed parentage. Thirteen of the four hundred and ninety-four persons were negroes. In 1910, 2.6% of the popula-

tion of the county were negroes, and thirteen is just 2.6% of four hundred and ninety-four. So that the large number of feeble-minded now in the county cannot be laid to the negro race nor to the immigrants, but rather to the deterioration of the native stock, or else the perpetuation of the mental defects of the old stock.

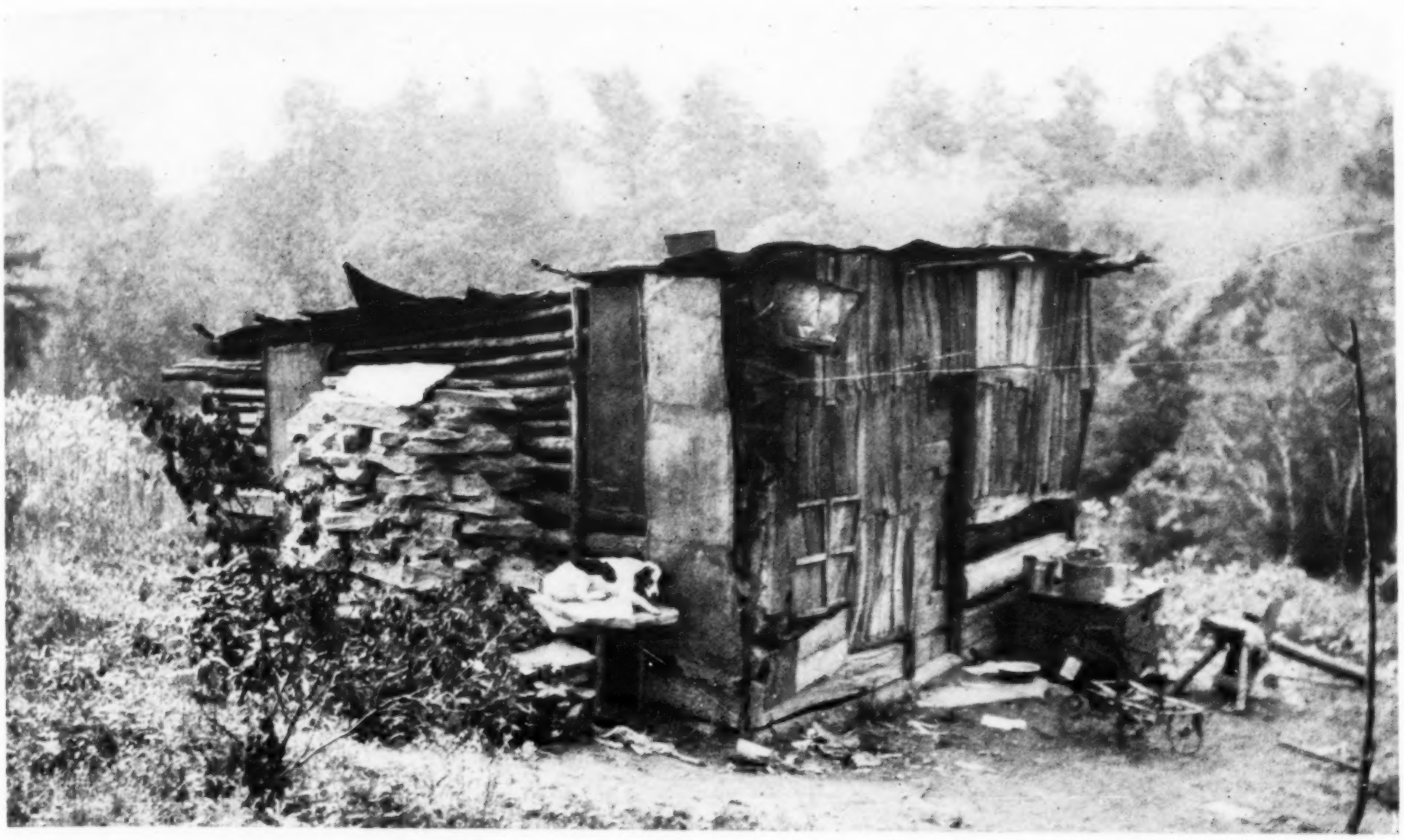
In the study of the feeble-minded at large in the county, the fact was brought out that there were proportionately just twice as many in the rural districts as in the cities; also that the mining districts had a much larger proportion of feeble-minded than the agricultural districts. This last fact is probably partly due to the geographical characteristics of the mining districts where the hills are so steep as to be entirely unsuited for agricultural purposes, and for that reason most of the land belongs to the coal companies, thus affording space where defective families may build their shanties and live undisturbed. Another causative factor is that defectives may work in the mines more profitably than on farms because steady work is not required and many opportunities are afforded for working under direction in jobs that make no call on initiative.

A careful comparison was made of the number of feeble-minded in each township and the average amount of township aid given yearly in those townships. It was found that where the proportion of feeble-minded at large in the community was high, the amount of aid given was correspondingly high and where the proportion was low, the amount of aid given was correspondingly low. There seemed to be a direct relationship between the two factors.

As has already been mentioned, heredity histories of varying thoroughness were obtained for all of the feeble-minded in the county. Seven families were found to which belonged 144 feeble-minded persons, or 26.8% of the total number of feeble-minded now living in the county. Of this number, twelve were in the county institutions and 132 were at large. Seventy-eight of these feeble-minded persons, five in the county institutions and the others at large, or 14.5% of the total in the county, belonged to a highly inbred family of defectives which has been called the Hickory Family. Sixty-two separate Hickory families were found living in the county of whom forty-eight were centered in one township. It was discovered that all were descended from a common ancestor who came to America from a French port in the days preceding the American Revolution. He married an Indian squaw and settled in the back woods of Pennsylvania. His six sons and one daughter emigrated to Ohio about the year 1800 and took up land near each other bordering a creek. Descendants of five of these children are now living in the county studied. The oldest of the brothers, who has been called Happy Hickory, was undoubtedly feeble-minded. Seventy-five of the seventy-eight feeble-minded Hickorys now in the county are lineal descendants of this man. Thirty-five of these, because of the close inter-marrying, are also lineal descendants of some one of his sibs. A summary of the 401 descendants of Happy Hickory has been made. Eighty-seven, or 21.8%, of these did not reach an age beyond fourteen years. One hundred and forty, or 34.9%, could not be classified because of lack of information or youth. Of the remaining 174 who reached an age beyond fourteen years and about whom definite information was gained, 51.1% were known to be feeble-minded and another 17.8% are suspected of having been so.

AN INBRED FAMILY

This family is highly inbred, probably partly because of the geographical features of the township in which they live, which is the one having the steepest hills and the most inaccessible ridges in the county, and also because they are largely ostracized by their neighbors, both of which factors tend to limit selection of mates. Of eighty-nine marriages shown on the chart made of Happy Hickory and his descendants, fifty, or 56%, are cousin marriages of varying degree, ranging



A HOME THAT SHOULD BE BROKEN UP

In this cabin live two of the Hickories (second cousins) and their two young children. Both husband and wife are decidedly feebleminded, and it is certain that all their children will be. It is sometimes a crime for society to break up a family; but it is unquestionably a crime for society *not* to break up this one, segregating the members for life. (Fig. 5.)

from double first cousins to third cousins. Twenty-one of the marriages are between persons closer of kin than second cousins, and twenty-one others are between second cousins.

The most prominent characteristic of the family is their absolute dependency. Thirty-three of the forty-eight Hickory families living in the one township received township aid during the fiscal year June 30, 1915 to June 30, 1916. Twenty-three of the direct descendants of Happy, together with four relatives in collateral lines, have been in the county infirmary. An old record, dated a short time after the infirmary was opened in 1857, reads, "Hank Hickory, his wife, and seven children applied for admission. Were not allowed to stay by the directors." The first inmates of the county children's home, when it was opened in 1878, were three Hickory children transferred from the county infirmary. Twenty of the direct descendants of Happy Hickory and twelve others in collateral lines have been in the children's home.

Members of the family also have thieving and immoral habits which, together with their habit of dependency, make them most undesirable persons to have at large. The cost of the family to the community in public support and private charity as well as by petty thieving, the breaking down of moral standards, and the spreading of infection, especially trachoma and venereal diseases, cannot be estimated. And no doubt the adjacent counties, where other Hickory families are living, have to bear a like burden.

SUMMARY

Therefore, to summarize, 20 feeble-minded persons from this county are in the institution for the feeble-minded, and 21 in other State institutions. Thirty-two are in the county infirmary, 10 in the children's home, and 494 at large in the county, making a total of 577 feeble-minded persons having a legal residence in the county, which is equivalent to 1.06%, or 10.6 persons to every 1,000 of the population.

Although 83, or 14.3%, of the total number of feeble-minded are in various institutions, only 20, or 3.4%, are properly segregated in an appropriate institution, the institution for feebleminded.

If we assume that 1% of the population of the entire State is feeble-minded, it means that Ohio has within its borders some 47,000 feeble-minded persons, of whom only 2,200 are now properly segregated. However, a fairer way to estimate the total number in the State would be by other surveys in other representative parts of Ohio. The county which has been surveyed is probably representative of the hilly counties in the southeastern part of the State. The fact that one feeble-minded man left at large five generations ago is responsible for seventy-five feeble-minded persons living at the present time makes one pause to wonder what the condition of things will be five generations hence, if the present generation and their descendants are allowed to reproduce their kind. However one looks at the matter, it is evident that if the problem of control of the feeble-minded is to be met by segregation, provision in Ohio must be made on a much more extended scale than is at present contemplated.

Some Eugenic Aspects of Military Registration

Selective draft in the United States will produce such far-reaching effects that everything connected with it should be scrutinized carefully by eugenists. It is of the utmost importance that men should not be sent to the front who will be more useful at home, and this means that many of the best educated men of the nation should be exempted. These men, however, having less frequently dependents, are the least likely to claim exemption, as is shown by the figures for registration in Pittsburgh. In four of the wards that are among the poorest in the city, eugenically, the proportion of exemptions claimed is 58.2%, while in four of the best wards it is 50.5%. Of the total white registration, 60.5% claimed exemption, whereas of the total colored population 66.7% claimed exemption. In such a case, the attitude of the exemption boards is all-important, and it is to be hoped that men will be appointed who will realize the eugenic as well as the military needs of the country. In this connection the attitude of some of the registrars was very offensive: Three men of my acquaintance were bulldozed out of making a proper entry of their occupation. Fortunately, the stupid rather than the intelligent men would be most often victims of such tactics.

Roswell H. Johnson,
University of Pittsburgh.

Eugenics and Military Pensions

The question of pensions after the war was discussed by Major Leonard Darwin, president of the Eugenics Education Society, at the Galton Anniversary meeting in London, Feb. 16. He pointed out that the soldiers and sailors are in many respects a superior lot of men, on the average; and that those who were wounded are likely to be, eugenically, superior to those who were not. These two facts, he thought, should be borne in mind when pensions are allowed. He commended the provision which awards an allowance for each child of a pensioner, but condemned the limitation which excludes children born after the pensioner left service. In the interest of eugenics, he thought an allowance ought to be given for each child, no matter when born; and for this purpose the allowance given to a childless wife might be reduced. Furthermore, he thought that those who were pensioned because of tuberculosis and similar defects should be given less encouragement, provided it were shown that such defects had a hereditary basis. In short, one of the objects of the pension system should be to encourage the better men, and those only, to have large families after the war.

LARGE FAMILIES

In Normal Stock, Those of Nine and Ten Children Are Found by Alexander Graham Bell to Show the Fewest Premature Deaths and the Largest Percentage of Longevity—Family of from Six to Eight Children Seems to be Most Favorable to Longevity of Mother—Conclusions Drawn from Slum Statistics Are Misleading

THOSE who preach birth control are responsible, it is to be feared, for the gradual creation of an idea that large families are an evil. This idea is false and dangerous. For the sake of eugenics, it is important that it be not spread. It is being created by such statements as the following:[1]

> Unregulated childbearing means a progressive decline in the mother's health accompanied by progressive debility in her offspring.
>
> Ample proof of this statement—if proof were needed for such a simple truth—is furnished by the investigation conducted by Dr. Alice Hamilton into the child mortality among 1,600 families in the Hull House district, Chicago. It was found that, as the number of children increases, the death rate goes up, so that in families having eight or more children, for example, the mortality among them is two and one-half times as high as in homes where the number of children does not exceed four.
>
> Similarly, tables compiled by the Children's Bureau at Washington in its "Johnstown Survey" bring out graphically the grim fact that the large families lauded with such vociferousness by the advocates of large armies only serve to fill the ranks in our hospitals and the rows in our graveyards.

The two studies quoted deal with large families in a class of the population characterized by economic straits and frequent destitution. If a father is barely able to support two children with the necessities of life, if the children inherit from both parents inferior physique, if the parents are deficient in intelligence, it is pretty certain that frequent childbirths will mean frequent child deaths *for that family*. In such a family it would be much better if only a few children were born.

But to argue from such a case that large families in any class of the community mean progressive debility in offspring is certainly illogical.

In fairness it must be said that those who preach the desirability of few offspring do not always make this argument directly. More frequently, perhaps, it is only inferred from their statements. Constant repetition, without qualifications, of the declaration that large families mean high infant mortality and weakened children, naturally creates the impression that such a statement holds good in all classes of the population. It is the purpose of this note to sound a warning against such a misunderstanding. Large families in the slums may be considered undesirable; unregulated child-bearing for any woman may even be considered undesirable; but this does not make it undesirable to know the biological facts about large families, separated from the influence of poverty.

It is doubtless true that in the Hull House district, where many children have feeble and unintelligent parents and lack the necessities of life, a large family means weakness. But the reverse is true in normally sound stocks, in sections of the population which have average intelligence, physique, and prosperity. Abundant evidence could be cited to support this statement. One of the most striking bits is that recently worked up by Alexander Graham Bell.

Dr. Bell has for some years been making a study of facts contained in the published genealogy of the Hyde family in America, with special reference to the longevity of its members. One of his more recent tabulations[2] shows the duration of life of sibs (full brothers and

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[1] Birth Control Review, 1, p. 12. New York (104 Fifth Avenue), February, 1917.

[2] The data can be found in the Beinn Bhreagh Recorder (xx, p. 201), a copy of which is on file at the Smithsonian Institution. Dr. Bell is preparing to publish the whole investigation shortly. Thanks are due to him for permitting this use of his figures in advance of publication, and to Sewall Wright for preparing the two graphs.

sisters) compared with the number of them in each family.

This table (I) deals with 2,964 individuals. If a random sample of a hundred be taken, and the career of each one followed, their history will be represented by the graph in Fig. 6. The very large and very small families are at the sides, the middle-sized families in the middle of the figure, and it is evident that the larger and smaller families had a relatively large death rate in childhood and early youth and a smaller proportion of members living to old age.

"ONLY CHILD" CARRIES HANDICAP

In the forty-one cases set down as "only child" a majority (58.5%) died young. If the families containing only two children be added, it is found that no less than 47.6% of the total (126) died before reaching maturity, and only 4.8% lived to be over eighty.

There were 168 persons belonging to very large families containing thirteen or more children. No less than 46.4% of these persons died in childhood (under twenty) and 5.9% lived to be over eighty.

It is evident that in this case both too few and too many brothers and sisters were unfavorable to long survival.

The proportion who died young was least, and the proportion who lived to be old was greatest, where the persons belonged to families containing nine and ten children. There were 683 such persons; 32.8% of them died young, and this is the smallest proportion dying under twenty of any of the groups shown in Table I. On the other hand, 9.7% of these persons lived to be over eighty; and this is the largest proportion living to old age in any of the groups shown in Table I.

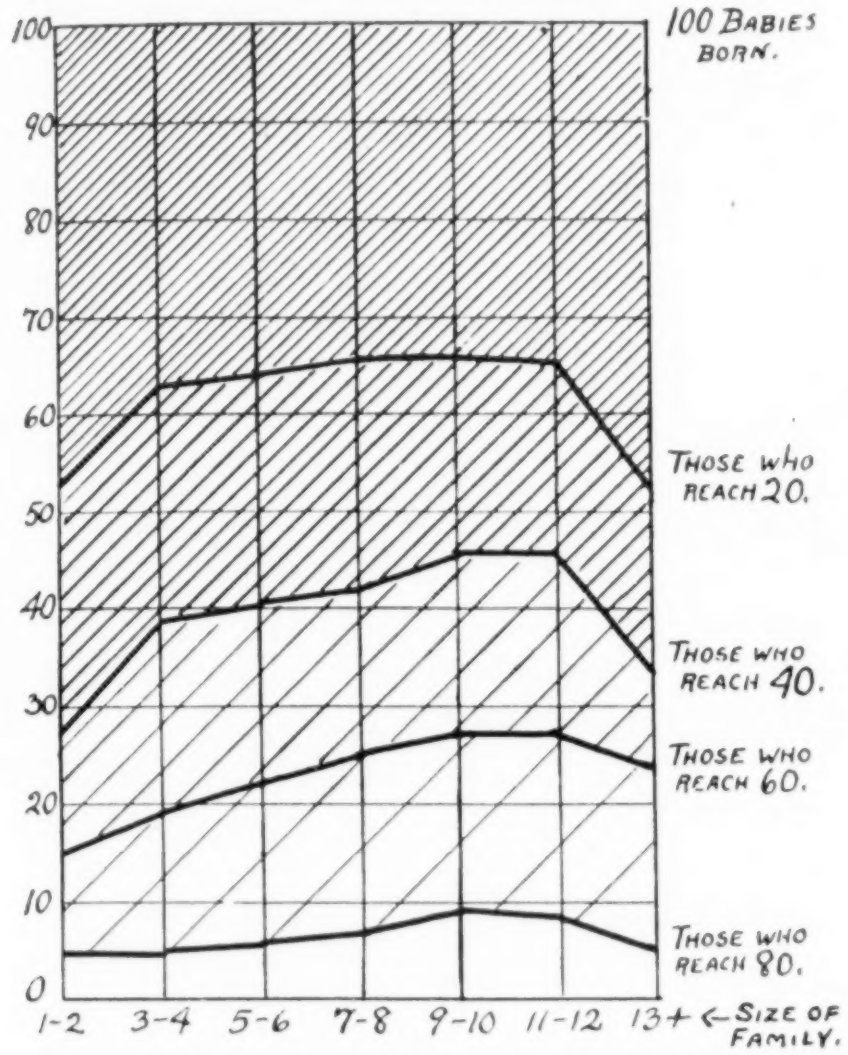
In short, the proportion of children who lived to old age increased with the size of family up to ten children, and beyond that it fell. There thus seemed to be a limit to the size of family consistent with the production of long-lived offspring, but this limit is very much higher than popular ideas would lead one to believe. Certainly ten children constitute a pretty sizable family; even the most enthusiastic eugenist is not likely to ask superior mothers to have as many offspring as that. Nevertheless the child with nine brothers and sisters has (statistically speaking) just about twice as good a chance of living to old age as has the child with only a single brother or sister, in a normal, healthy population.

But if the analysis of the figures is carried a step further, an even more striking result appears. It is evident from Fig. 6 that the greatest difference between the families of various sizes is in the amount of child mortality. It is important to know how the various sizes of family will rank, if differences in

TABLE I.—*Duration of Life of Individual Compared with the Number of His Sibs; Percentages Who Died at Ages Named*

Number in family	Total persons	Ages at death				
		20	20–40	40–60	60–80	80+
1	41	58.5	22.0	4.9	9.7	4.9
2	85	42.4	24.7	18.8	9.4	4.7
1 and 2	126	47.6	23.8	14.3	9.5	4.8
3 and 4	313	36.1	25.5	19.2	14.4	4.8
5 and 6	584	35.5	24.5	18.3	15.9	5.8
7 and 8	694	33.0	25.2	17.7	16.9	7.2
9 and 10	683	32.8	22.2	17.9	17.4	9.7
11 and 12	396	33.6	21.2	18.4	17.9	8.9
13 and more	168	46.4	17.3	13.1	17.3	5.9
	100.0%	35.2%	23.4%	17.7%	16.4%	7.3%
	2964	1044	693	525	486	216

child mortality are eliminated. To show this, Dr. Wright has prepared Fig. 7, in which only those individuals who reached the age of twenty are considered.



HISTORY OF 100 BABIES

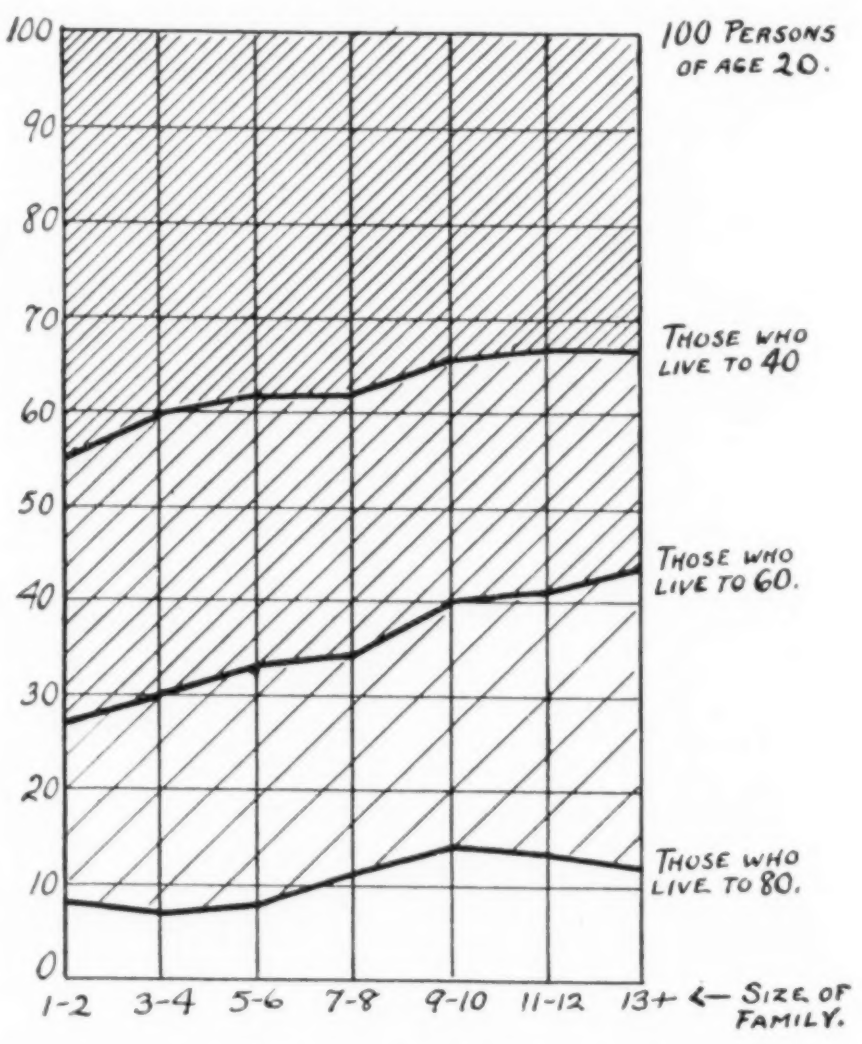
The top of the diagram shows the children "starting from scratch." By following down the vertical lines, one can see that their longevity depends largely on the size of family from which they come. Those who had ten or a dozen brothers and sisters are most likely to live to extreme age. (Fig. 6.)

LARGEST FAMILIES GAIN

Comparison of this with the preceding graph shows at once that the small families are still handicapped, but that the largest families have made a gain. A family of ten children is no longer the most favorable one; the families of thirteen and more have just about as large a proportion of members living to an advanced age. The bigger the family, the better off are its members, if survival beyond the age of twenty be the measurement, as in this case.

It is evident, then, that the small families (though they are not very small, either, by present-day standards) make the poorest showing under all conditions; their members are handicapped at all ages. The larger families—those around ten children—make the best showing at all ages, few of their members dying young and many living to old age. Children in the very largest families suffer from a high death rate when young, but once they reach maturity, the members of these very large families not only suffer from no handicap, but they equal or excel all others in longevity.

The explanation of this is fairly obvious. In any collection of records such as the Hyde genealogy furnishes, most of the one and two-child families are those in which one parent was either feeble or died prematurely. It must be remembered that birth control was little practiced in this group (most of the births fall in the first half of the last century). The average family contained five or six children, and when parents had only one or two it was a pretty good indication of some constitutional weakness that would make itself felt in the children's heredity.



ADULT MORTALITY

If child mortality is eliminated, and only those individuals are studied who live to the age of twenty or longer, the small families are still found to be handicapped; but in general it may be said that the larger the family, the longer a member of it will live. (Fig. 7.)

On the other hand, the mother who bore ten children was certainly of

vigorous stock in most cases. Her children naturally inherited her vigor, and it meant longevity for them. There may have been some disadvantage arising from the large number of offspring, but whatever it was, it was counterbalanced by the very great advantage which comes from the inheritance of vigor, vitality, and a resistant constitution.

INFANT MORTALITY

The higher infant mortality in families of more than ten children reflects the only disadvantage which Dr. Bell's study shows to inhere in large families. The fact that the surviving members of these big families have extraordinary longevity indicates that one's constitution is not permanently impaired by having a dozen brothers and sisters. The high death rate in childhood may be largely due to the fact that the mother has more children than she can properly look after. If this be the correct explanation, then it is evident that whatever disadvantage arises from having even an extreme number of offspring, is not of the kind that results in permanent debility of these offspring. Considering only the factor of heredity, it is evident that there is no danger of racial deterioration from large families: that the families can hardly be too large, under normal conditions. The weak children of a population come not from large families, but from small families.

Of course this does not mean that a small family necessarily connotes weakness of its members. Nor is it intended here to suggest that superior women should bear ten children apiece. It is only desired to point out that, in a normal stock, a child with nine brothers and sisters has, on the average, much more vitality and strength than a child with only one, because it has, on the average, a better heredity.

If superior parents want a large family, they ought not to be discouraged by the widespread but false idea that every child beyond the second or third is likely to be progressively handicapped. If any is handicapped, it is the first-born,[3] but the effect here is not very great. The really important factor in determining a child's vitality is not the number of brothers and sisters who have preceded him, but the kind of stock he comes from. Large families in superior stock will produce superior children; large families in the slums are likely to produce inferior children. In discouraging the latter families, care should be taken not to discourage the former.

EFFECT ON THE MOTHER

The foregoing discussion has been limited to the effect on the offspring of having a large number of brothers and sisters, and it has been shown that the alleged "progressive debility" is a misunderstanding. Nothing has been said about the alleged "progressive decline in the mother's health." That question is too large to be discussed here, but it may be noted that in this case, too, the results depend largely on the kind of inheritance the mother has. Powys' careful study[4] of the admirable vital statistics of New South Wales shows that the longest-lived women are those who have had from six to eight children. A larger family than that apparently is unfavorable to the mother's physique, while a smaller family also goes with diminished vitality. This of course does not mean that a woman of deficient vigor could prolong her life by bearing seven children; it merely means that the women with the greatest inherent vigor tend to bear about that number of children, without suffering any diminution in longevity.

The size of a family must naturally be determined by many considerations besides eugenics. As far as eugenics alone is concerned, relatively large families, in the superior part of the population, are desirable from the point of view of the parents and the children, as well as the race. In eugenically inferior parts of the population, the smaller the family the better for all concerned.

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[3] On the handicapping of the first-born. University of London, Galton Laboratory for National Eugenics, Eugenics Lecture Series X. London, Dulau & Co., 1914. An extended review was given in the JOURNAL OF HEREDITY, vi, pp. 332–336, July, 1915.

[4] Data for the Problem of Evolution in Man. On Fertility, Duration of Life, and Reproductive Selection. By A. O. Powys. Biometrika, iv, pp. 233–286, London, 1905.

HORNED HORSES

Several Well-Authenticated Cases on Record—Not Certain Whether They Are Mere Abnormalities, or Whether They May be Looked on as Reversions to an Ancestral Condition—Manner in Which Horns are Formed

J. E. MILLER

Physician and Surgeon, Rogersville, Tenn.

FROM the Eohippus of the lower eocene formation, with its four toes, and not larger than the house cat;[1] on through millions of years of transition to the Equus or horse of modern times, no animal, perhaps, has shown greater evolution than the horse. It was a long time before paleontologists were able fully to prove the fact that this animal at one time possessed five toes. Will it also be discovered that it possessed horns at one stage of its history?

Herewith is a photograph of a two-year-old filly owned by Dr. J. J. Koger, of Rogersville, Tenn. The filly's sire is of the "Chief" family of Kentucky.

A horn is located on the lower border of the right ear, about 1 inch from the attachment of ear to head. It is firmly attached to the muscles, skin and deep parts of the ear, is moveable, that is, it swings and dangles on movement of the colt's head. It is 3¼ inches long, and a little more than three-eighths of an inch in diameter at base, and has rings and lamination somewhat similar to the horn of sheep and cow. It is of the same color as the hoof and is as hard as the horn of sheep or cow. It sheds one-third of its length every spring about the middle of March.

The filly seems to suffer no more inconvenience from the presence of the horn, than does a lady from the gold-set pearl or pendant in her ear.

The *New York Sporting Times* of March 4, 1905, reports two cases of horned horses, near New York City, owned by A. Day.

Mr. Darwin and other scientists speak of horned horses.

The former says: "In various countries horn-like projections have been observed on the frontal bones of the horse: in one case described by Mr. Percivall they arose about two inches above the orbital processes, and were 'very like those in a calf from five to six months old,' being from one-half to three-quarters of an inch in length. Azara has described two cases in South America in which the projections were between three and four inches in length: other instances have occurred in Spain."[2]

Azara's account is as follows: "I have heard for a fact, that, a short time ago, a horse was born in Santa Fé de la Vera Cruz, which had two horns like a bull, 4 inches long, sharp and erect, growing close to the ears; and that another from Chile was brought to Don John Augustin Videla, a native of Buenos Ayres, with strong horns, 3 inches long. This horse, they tell me, was remarkably gentle; but, when offended, he attacked like a bull. Videla sent the horse to some of his relatives in Mendoza, who gave it to an inhabitant of Cordova, who intended, as it was a stallion, to endeavor to form a race of horned horses. I am not aware of the results, which may probably have been favorable, for the heifers of the hornless bulls are productive, as we shall see further on."[3]

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WELL-DEVELOPED HORN ON A MARE'S EAR

This single horn, more than 3 inches long, sheds part of its substance every year, just as the horns of many other animals do. A number of cases have been previously reported, of horses with horns, but the explanation of these growths is something of a mystery. (Fig. 8.)

Percivall[4] wrote: "Some time after joining the Eleventh Dragoons, I was asked by an officer of the regiment whether I had ever seen a horse with horns, belonging to L Troop. This horse had once or twice been the subject of conversation at mess-table, but it struck me to be a hoax, and as such I paid little or no attention to it. A year and a half having elapsed, he was admitted into the hospital stable, with an attack of spasm of the intestines, when the dragoon pointed out the excrescences above alluded to, placed about two inches above the orbital process of each frontal bone, in the center of the forehead, 2 inches apart, projecting from one-half to three-quarters of an inch from the surface of the frontal bones, very much resembling what is felt in young calves five or six months old."

WHAT IS THE EXPLANATION?

Should these horn growths on horses be considered as a reversion to a type, or merely abnormalities? Certainly the evidence is not sufficient to warrant the conclusion that the horse in its descent possessed horns, but it is interesting to speculate on the subject. All the cases reported seem to be mere extensions of the skull, except the present one on the ear. If they are to be classed as freaks, why do they come in twos just as in all horned animals? And why are they so uniformly located? If the other cases were classed as

[4] Percivall, Charles. Horns in the Horse. *Veterinarian*, Vol. i, p. 274, July, 1828.

reversions to a type, this one on the ear might be termed a variation, since in the variation of the rhinoceros' horns, they may be superficially attached. That is, it does occur where the horn has no connection with skull-bone below. Strabo of the first century mentions that horned horses of India were not uncommon. Other early writers reported horned horses. On the other hand, Prof. Matthews of the American Museum of Natural History, states that no specimen they ever found of the ancient horse had any indication of horn cores on the skull. Prof. Matthews' investigations have covered no less than twelve stages in the evolution of the horse, over a period of some three million years.

Horns in cattle, sheep, rhinoceros and others of the higher vertebrates, are composed of two substances, (1) an external shell, the true horn, which takes its origin from the skin, epidermis. Fundamentally it is the same kind of tissue from which the hairs, nails, scales of reptiles and fishes, and feathers of birds are formed. All these widely different structures are in their earliest stages very similar, and are derived from the same primordial cell, the epiblast. (2) An internal core or bone, derived from an entirely different cell, the hypoblast. These cores give support to the external shell. Without such support a horn would be of no service as a weapon of offense or defense. However, feathers, nails, hair, scales on fish are normally without bone support. But scales on sharks and turtles, and some of the fishes, especially geologically old fishes, are usually supported by special bony structures. In short, epidermal structures may or may not be associated with bone and these structures *can* develop without a bone support.

Just what the structure is of the horse's horn, cannot be determined without a cross-section. By this means it could be definitely known with what horn, cow's, or rhinoceros', it is most nearly related. It has all the appearance of being a true horn. Its shape, rate of growth, etc., indicate that it is a real horn. In an early geologic period we find that the horse and rhinoceros took origin from the same stem. If the horse at that time possessed horns, this is a case, perhaps of reversion. I will advance one other theory; as has been mentioned, the hair and horns are derived from the same structure, and this is possibly a modified hair cell, which has been caused by something being knocked out of adjustment accidently, during the horse's embryonic stages. But I know of no instance of horn formation from modified hair follicles, to support this suggestion.

Survey of Musical Ability in Schools

All children in the seventh and eighth grades of the Sioux City schools were recently given psychological tests of musical ability by Dean Carl E. Seashore of the University of Iowa, and his assistants. These exact tests measure the amount of inherent talent which the child possesses, and seventy children were selected, who showed unusual promise and were considered worthy of special encouragement. Of these, twenty-four had never had any training; the rest had had some. It is interesting to note (says *School and Society*, p. 612, 1917) that Dr. Seashore had no information about the previous performance of any of the pupils examined, but the two whom his tests showed to be the most gifted were actually two who have a local reputation as musical prodigies, one of them, a girl of twelve years, being a concert pianist. Dr. Seashore believes that all fifth grade children should be given tests of musical ability, with a view to encouraging those who show talent. His work, which has extended through many years of experimentation, marks an important step forward in vocational guidance and the selection of those who have inborn special abilities, and is to be as widespread as possible.

VARIATION IN ARTICHOKES

Bud Sports Frequent and Offer Promise of Improving Commercial Strains to a Considerable Degree, if They Are Isolated—Methods of Culture

A. D. SHAMEL
U. S. Department of Agriculture, Riverside, Calif.

IN THE writer's neighborhood of Riverside, California, is a garden of artichokes, *Cynara Scolymus*, Linn., perhaps about one-half acre in extent, grown for the purpose of supplying the local markets with this vegetable. While this artichoke is largely unknown in American households, its popularity in southern California seems to be growing rapidly, so that at the present time it is not only commonly grown in many home gardens, but is also a staple vegetable found on the menus of nearly all of the first-class hotels and restaurants during the late winter and spring months.

The artichoke[1] is a hardy perennial, a native of North Africa and South Europe. Pliny mentions it as a vegetable that was highly esteemed by the Romans. It was introduced into England from Italy about 1548. Its introduction into the United States was probably of comparatively recent date, and, as yet, its cultivation on a commercial scale is largely limited to certain sections of some of the southern and western states including California. Most of the Eastern visitors to southern California, with whom the writer has come in contact, have stated that they had never eaten this vegetable previous to their experience here. Many of them have become very fond of it.

The plant somewhat resembles a large thistle, and, indeed, is often mistaken by visitors for some strange thistle. The stalks and leaves are numerous, large, fleshy, and have a coarse spiny appearance. The leaves are covered with an ash-colored cottony down, are of many peculiar and striking shapes, commonly pinnatifid or pinnatilobed. The flower stems grow erect and attain a height of from four to six feet. The flower heads are usually somewhat globular in shape and consist of imbricated, oval, spiny, broad scales, thickened at the base, of green, or purplish green color, enclosing a mass of flowers in the center. These flower heads in an immature state contain the edible parts, a fleshy receptacle usually called the "bottom," freed from the bristles and seed-down, commonly called the "choke," and the thick lower part of the imbricated scales or leaves.

METHOD OF USE

The common method of using this vegetable here is to boil the immature flower heads until tender. Drawn butter, a sauce, or a salad dressing is provided, frequently a thick mayonnaise. The scales of the flower head are picked off one by one and the base of each is dipped into the sauce and eaten. The "bottom" is then carefully freed from the seed-down or "choke" and is cut up and eaten with the sauce. In France the "bottoms" are often fried in paste and enter largely into ragouts. They are occasionally used for pickling. The flowers are very large and handsome and possess the property of coagulating milk.

The stalks of each plant vary greatly in the time of bringing their flower heads up to the right stage of maturity for cutting. The top flower head of each stalk usually matures first and the lower ones, which are usually of small size, mature later in the season. For this reason the period of production of a field of plants in some seasons covers two or three months, and is frequently from four to six weeks. This

[1] The Treasury of Botany, p. 371.

TWO DISTINCT TYPES OF ARTICHOKE

Typical leaves and flower heads of two strains of artichoke in the Victoria bridge garden at Riverside, Cal. That at the left differs markedly, in both leaves and flower-head, from the one at the right. It is possible that these are both descendants of the same parent plant and that their divergences are to be accounted for by bud variation. Such variation is so frequent, and often breeds so true, that it offers a quick and effective way of improving many important fruits and vegetables. (Fig. 9.)

period at Riverside for the season of 1917 was from about April 1 to about June 15. The number of flower heads produced by each plant varies greatly, some developing only two or three, while others bear twelve or fifteen or more good heads. In some cases the stalks are thinned so that the remaining ones will develop larger and superior heads.

In the artichoke garden near the writer's home there are examples of several strains. The plants of the various strains differ with respect to their habits of growth, number of shoots and leaves, particularly with regard to the shape and arrangement and other characteristics of leaves, number and shape and other characteristics of flower heads, time of maturing the flower heads, and other well-defined characteristics. There are frequent examples of at least three common strains of which two in particular stand

THREE LEAVES FROM A SINGLE PLANT

The wide variation shown in the characteristics of the artichoke is strikingly brought out by the above photograph of three leaves from a plant growing in the Victoria bridge gardens at Riverside, Cal. The fact that plants vary has always been recognized in a theoretical way, but many horticulturists have overlooked the fact that these variations possess great commercial importance. (Fig. 10.)

out as most striking in the preliminary study thus far given these plants.

The plants of one of the strains produce flower heads having a globular shape. The leaves of these plants are usually pinnatilobed. The plants of the other strain bear rather elongated flower heads, making them somewhat cylindrical in shape. The leaves of these plants are usually pinnatifid. Photographs showing the typical flower heads and leaves of the plants of these strains are shown in Fig. 9.

Inasmuch as the plants in this garden have all been propagated asexually, from offsets or suckers, largely from one parent plant, it is but logical to conclude that the variability of the plants is due to bud variation . The suckers were detached from the parent plant in the spring before growth began. The writer hopes to be able to secure some selection of suckers from particular plants with a view to isolating the several strains represented in this field.

The leaf variations shown by some

of the plants are extremely striking. Owing to the large size and fantastic shapes of some of the leaves, this condition, providing easy comparison of leaf forms, is particularly interesting to those concerned with a study of bud variations. In Fig. 10 are shown some of the variable leaves borne by the same plant. Some of the plants in this field apparently present much greater variability than others. In some cases all of the leaves of the plant are comparatively uniform in size and shape while in others the leaves are extremely variable, ranging in shape from a single narrow blade to very finely pinnate forms, and in size from 1 to 4 feet in length. The scales of the flower heads vary in shape, size and color.

SELECTION PROMISES RESULTS

It seems probable that by careful selection of suckers from select plants, strains can be isolated in which the plants will produce a larger number of flower heads than ordinarily with a much larger proportion of edible matter and, as a consequence, be much improved for commercial cultivation.

Owing to the fact that the artichoke is very easily grown, at least under such conditions as those at Riverside, and furnishes a valuable vegetable, it seems that its planting in home gardens should be encouraged. The plants are very ornamental as well as useful and where it is possible to grow them, they constitute a desirable addition to the list of varieties of vegetables. The artichoke is now grown to a very limited extent in gardens on Long Island, in Connecticut and Massachusetts, and can probably be grown successfully in other northern districts providing the crowns are protected during the winter months. If a large planting is planned the rows should be about four feet apart and the plants set about three feet apart in the row. In the beginning it seems best, probably, to start with one, or at most but few plants, which can be purchased from seedmen or growers, then propagate the remainder of the garden from offsets by selecting those which have the fewest spines and whose leaf characteristics are correlated with the production of the largest number of most desirable heads. In this locality the plants may be set out from March to June and during the months of August and September. It seems probable that the plantations should be renewed every three or four years.

This paper is presented for the purpose of calling attention to an opportunity for the improvement of a valuable vegetable variety through bud selection.

The Egg Production of White Leghorns

The egg production of unselected White Leghorns averages about 130 for the first year, 120 for the second, and less than 110 for the third, drops to 85 in the fourth year and falls about 10 eggs a year after this up to the eighth year, according to Bulletin 148 of the Utah Experiment Station. Selected flocks have averaged 160 in America and 190 in Australia. The first-year production of a flock of White Leghorns is no indication of their total production: if it is high, the second year will be low, while if it is low the second will be high. The total production in three years will be about the same. If the first year record of a flock is high, selection of the high layers will materially improve the later production of the flock. If the record of the pullet year is low, there will be little value in selection, as even the lowest producer will make a second-year record above the general average. The average life of a White Leghorn appears to be about six years. The average production of the fourth year (eighty-five eggs) is equal to the average production given for hens of all ages in the United States. The average total production of a White Leghorn hen, during her entire life, is above 500 eggs, and may rise as high as 1,000.

REMARKABLE BUTTONBALLS

R. W. SHUFELDT, *Washington, D. C.*

IN THE March, 1917, issue of *American Forestry* (p. 146), I invited attention to the fact that the familiar globular flower-balls of the Sycamore or Buttonwood tree, ordinarily borne singly, are sometimes in pairs, the peduncle of the lower ball apparently being pressed into the side of the ball above, leaving a depression in the lines of the peduncles. An example of this condition, collected at Washington, D. C., was given by a photograph which I had made.

The description would lead one to believe that the condition was a rare one, and such was my impression at the time of writing the article, especially when I found, in the last edition of Gray's "New Manual of Botany" (1908), that not only was there no allusion to this condition, but on the contrary it is stated, in the description of these flower-heads: "fertile heads, solitary, hanging on a long peduncle" (p. 454).

Since publishing the above exception, I have examined a large number of trees in and about Washington, and I find that the condition is not nearly so unusual as I first supposed. The publication of the fact, however, has evidently been responsible for inducing a great many other people, in all parts of the country, to look into the matter, and not a few letters have been written to me on the subject.

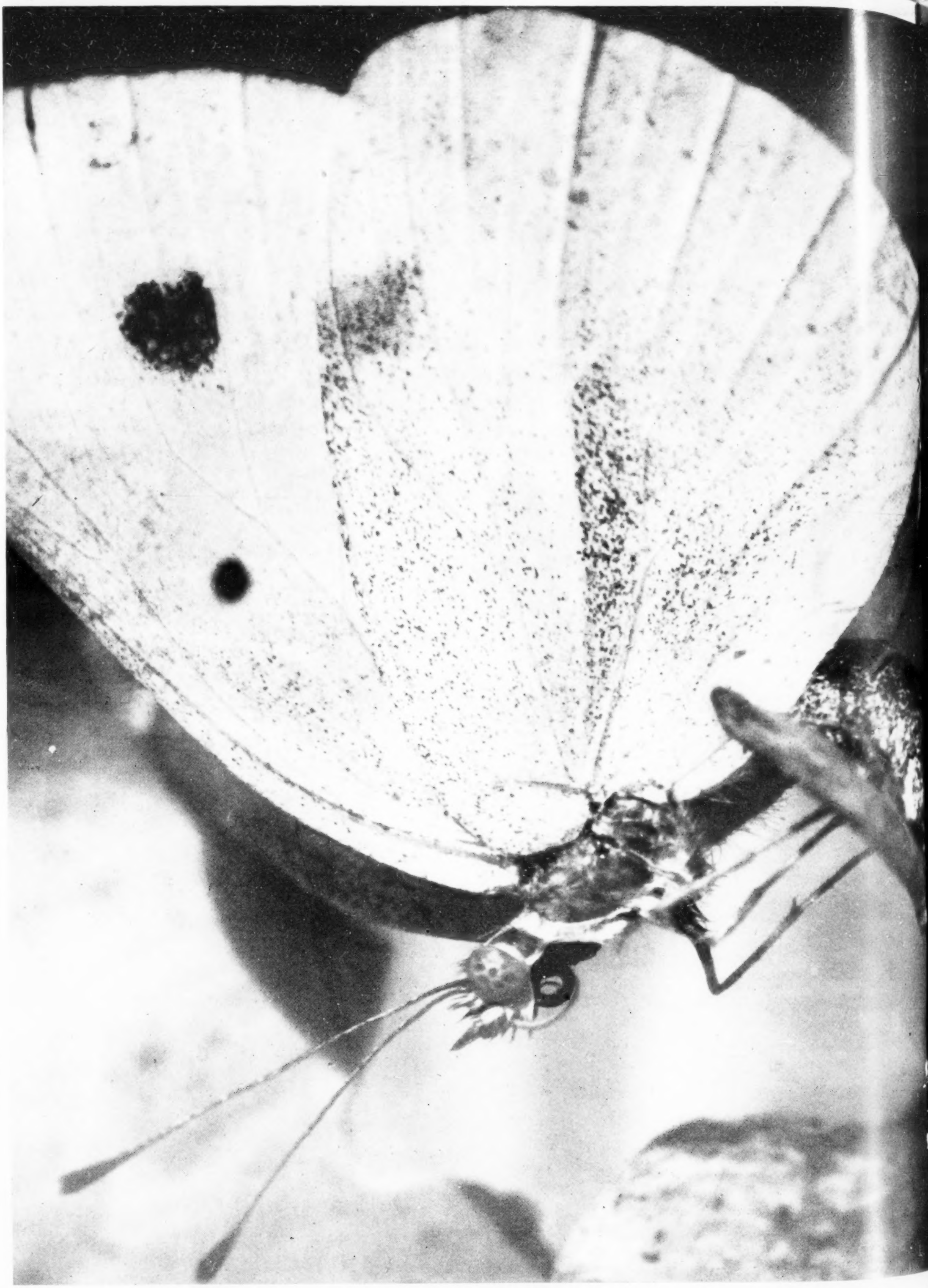
The *single* ball or flower-head is undoubtedly the normal condition; and it would be interesting to have any light thrown on the origin of the multiple ones, or if the latter ever occur on *typical* wild trees. Henry W. Scattergood, of Philadelphia, writes in regard to this tree: "I have a large specimen on the lawn of my home in Germantown, and on looking over the button balls lying on the ground, I found a number of the double variety which you describe as abnormal, also triple ones. There are a number of both still on the tree. . . . Am also mailing a couple of the double and one triple specimen under separate cover." In the triple specimen I found the peduncles to the balls all in line, as in my figure given in *American Forestry*. Personally, I have never seen the triple balls in nature or on other trees, and I was about to photograph the specimen, when Charles E. Mather, of Philadelphia, invited my attention to the fact (April 1, 1917) that they also occurred on the sycamores on his "Meadow Farm" at Brandywine. This correspondent topped the record by proving that the cluster sometimes contained as many as *four* balls, with the four peduncles all in line. Mr. Mather has some twenty sycamores on his place, all of which he carefully examined with the result of finding only this single example of four balls strung together. He states positively that "the native trees only have one ball." He sent me the four-ball specimen; and, while it had been somewhat damaged in the mails—the balls being about to go to pieces—I made a photograph of it; this is here reproduced to illustrate the condition. The superior half of the lowermost ball had become detached and broken up.

Mr. Mather has been so good as to make photographs of two of his sycamore trees, showing examples of three balls in a cluster or string, and these pictures I have in my possession. The Morris Nursery Co., of West Chester, Pa., under date of April 2, 1917, wrote Mr. Mather to the effect that "we sent you some years back the Oriental Buttonwood, the only kind we grow, as it is superior to the American Buttonwood."

This latter occurs, according to the botanies, pretty generally throughout the eastern half of the United States, but not west of eastern Kansas, while the range and habitat of the Oriental Buttonwood or Sycamore is still unknown to me. From the wide interest taken in the matter, it would appear to be worthy of further investigation, especially along the line of specific variation, not only of the flowers but of the trees as well.

A SYCAMORE "FOUR-IN-HAND"

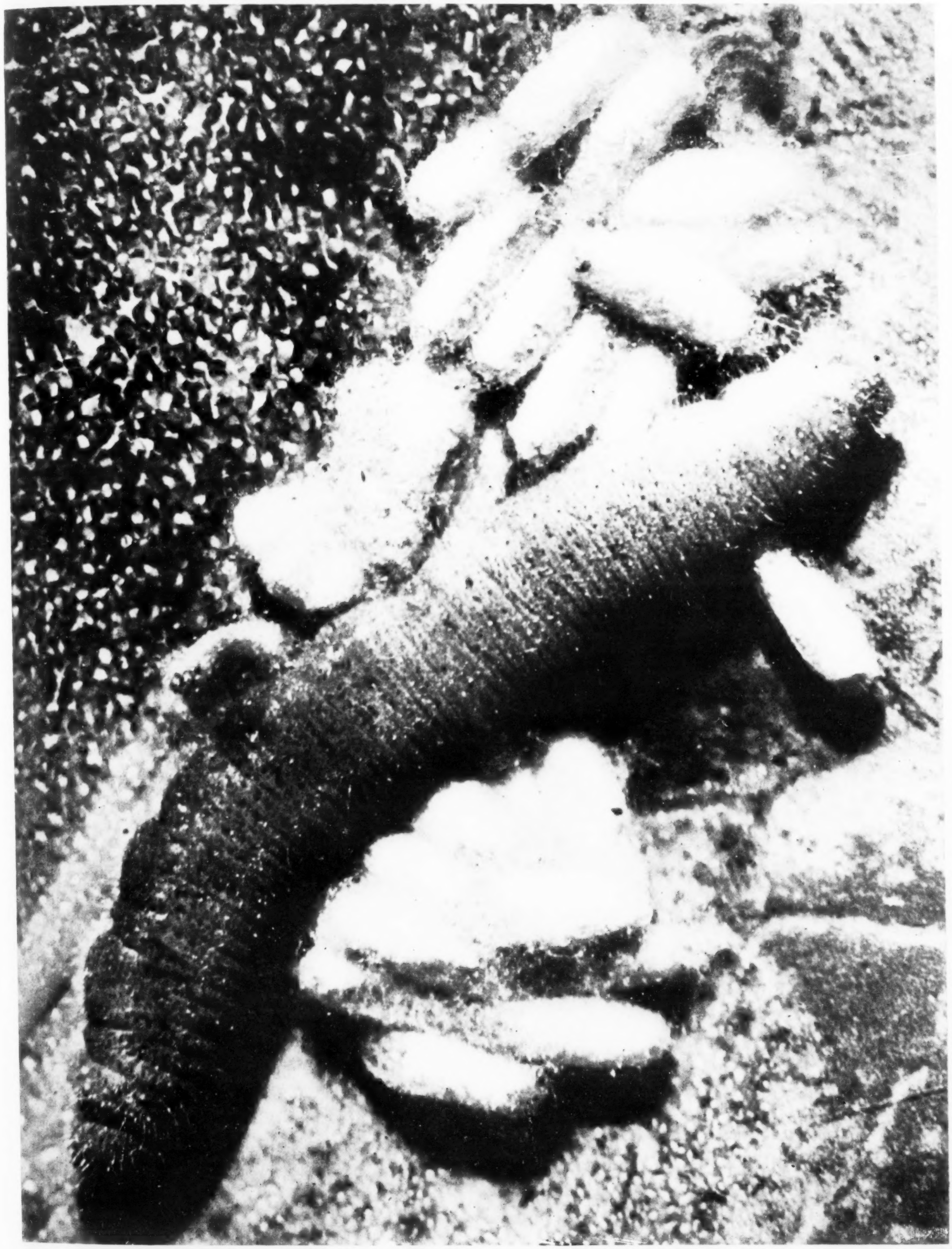
Ordinarily the flower heads of the oriental sycamore (*Platanus orientalis*), a shade tree widely grown in the United States, occur singly. But sometimes two, three, or even four are joined together, in which cases the stems are in line with each other. Photograph by Dr. R. W. Shufeldt. (Fig. 11.)



WHY THE CABBAGE BUTTERFLY DOES NOT INCREASE MORE RAPIDLY

The most destructive of the many enemies of the cabbage and related crops in the United States is t[he] cabbage[bu]t fly (*Pontia rapae*) which is shown above in the act of laying an egg on a cabbage leaf. The green worm w[hich ha]tches from this egg is shown in the second photograph; sometimes it is not discovered until the cabbage reaches the [fin]er [sta]ge.

1883 an ichneumon fly (*Apanteles glomeratus*) was imported from Europe to keep the cabbage worm in check. It lays its eggs in the body of the cabbage worm; the larvae which hatch from these eggs make a meal on the worm and then cut their way out and spin yellow cocoons beside his dead body. The number of cocoons shown in the photograph illustrates what a small chance the cabbage worm has of surviving this parasite. It is interesting to note that the parasite is in turn preyed upon by a superparasite, a little chalcis fly; "and so on down, ad infinitum," no doubt. If a cabbage grower finds cocoons of the ichneumon fly, he should put them in a box and put with them all the cabbage worms he can collect. He will thus aid the parasite to propagate, and get a good stock established in his garden. Copyrighted photographs by Brown and Dawson. (Figs. 12 and 13.)



BULL TERRIER BREEDING

Ancestry of the Breed is a Cross between White Bulldog and Black-and-Tan Terrier—Modern Standards Are Peculiar and Exacting—An Interesting Case of Intensified Line-Breeding

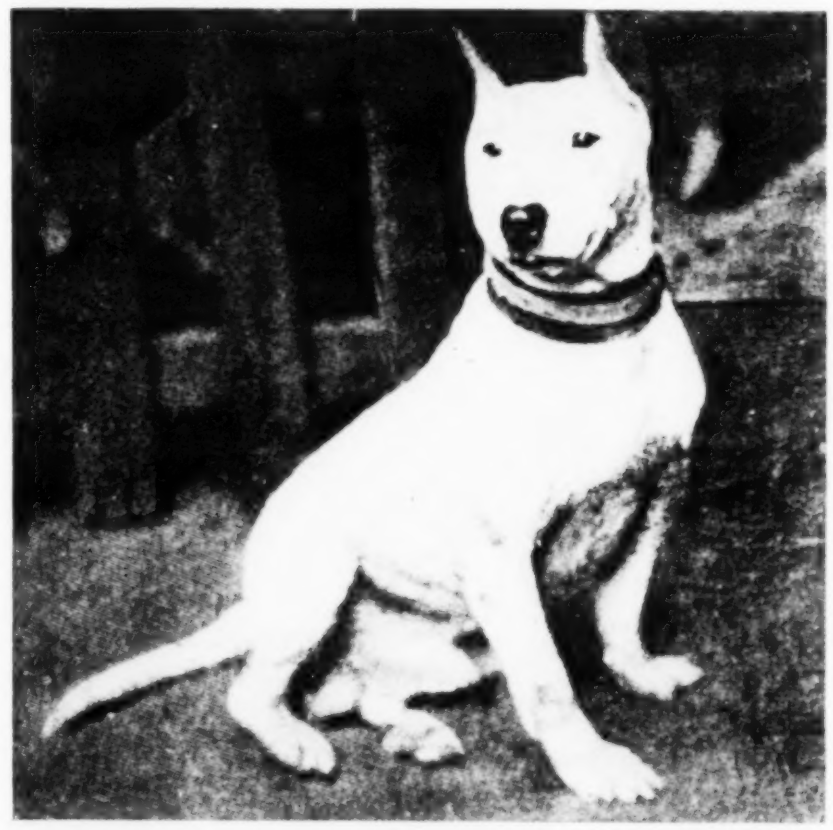
ROBERT DUNCAN COOMBS

Longmeadow Farm, Ridgewood, New Jersey

IN THE early part of the nineteenth century the name of terrier was applied indiscriminately to a number of breeds, as well as to a number of crosses and mixed breeds. The bull terrier of that period had a combined ancestry of bulldog and black-and-tan terrier. The current type of pit-bull or fighting terrier would seem to bear a closer resemblance to the Victorian-era bull terrier than does the modern bull terrier. This is due to the fact that careful breeding has established the standard bull terrier breed as an all-white short-haired dog fairly regular both in bodily type and mental characteristics.

It is unfortunate that the terrier used for fighting has been so frequently confused in the popular mind with the bull terrier. This misconception is so general that almost any short-haired, white, strongly built dog, which resembles the breed, will be called a bull terrier, however mixed its ancestry may have been and however bad its disposition. As a matter of fact the breeding of the better class bull terriers shows a pure ancestry for very many generations, as is proved by the standard all-white color.

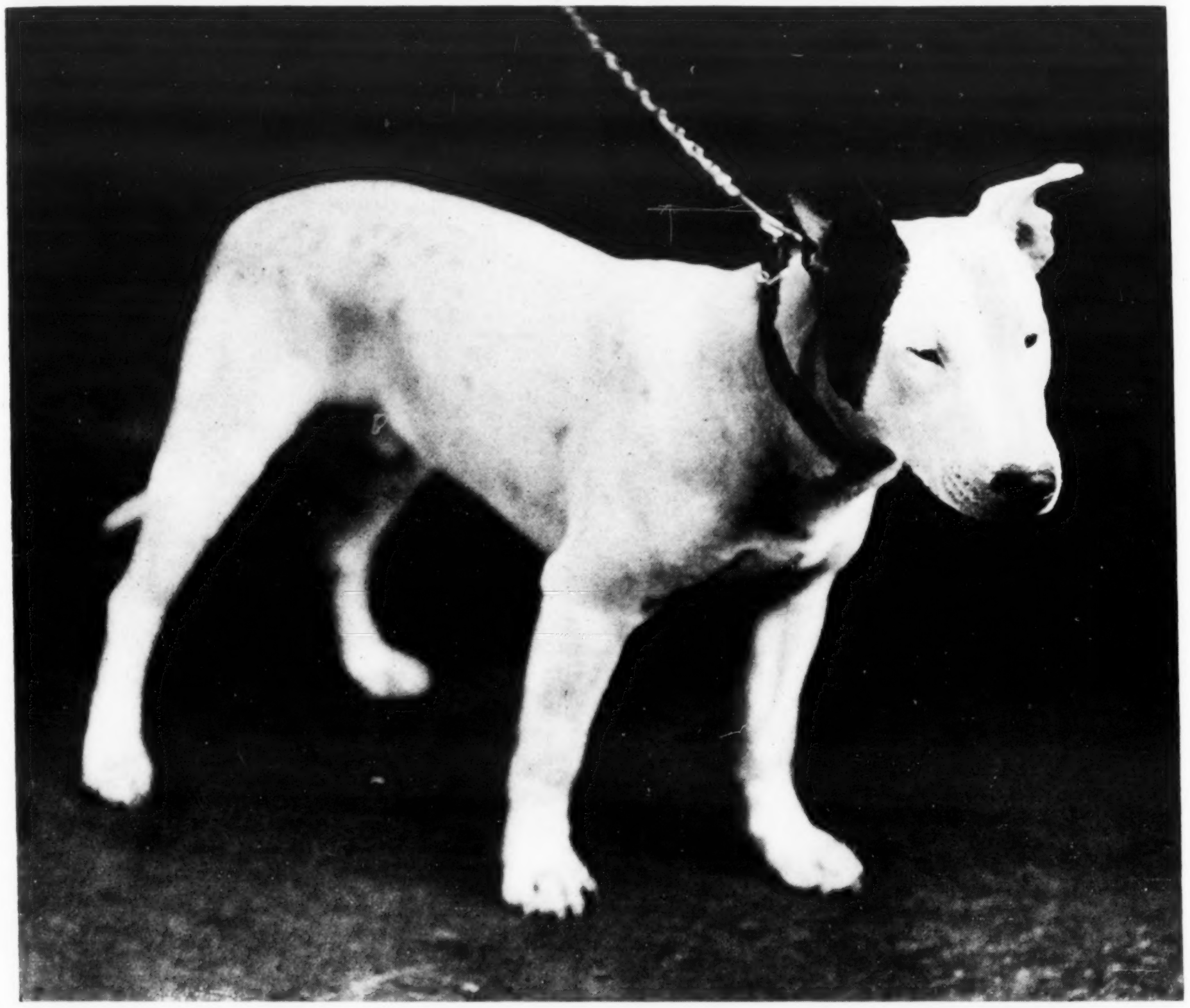
The "standard of the breed" calls for a dog of rather definite characteristics and of a type readily distinguishable from other breeds. Without exaggeration of any feature the animal should combine strength and agility. The head should be long, with the foreface filled up to the eyes, the muzzle wide, yet tapering; under jaw strong, lips tight and teeth meeting evenly. An overshot or undershot jaw is a bad fault, as is "lippiness." Neck medium and shoulders muscular but without distortion or heaviness. Shoulder blades wide, flat, and sloping well back. The ribs should be well sprung and the chest deep and wide. The legs big-boned with straight but not stilted forelegs. Feet "cat footed" and straight toed, tail straight, tapering, medium length and not carried above the level of the back. Coat dense, short, stiff and glossy. The color of the hair and skin *white* except that the nose and eyes should be *black*. Eyes "triangular" (sic), small, set close together and obliquely.



"OLD DUTCH"

He is one of the pillars of the Bull Terrier stud book, although his legs were "all wrong." His claim to greatness rested largely on the shape of his head, which was much admired by connoisseurs. After Watson, The Dog Book. (Fig. 14.)

From the above description it will at once appear that the typical bull terrier possesses very marked characteristics. It will also be noticed



MICHAEL, A "MARKED" DOG AND SHORT IN FRONT LEGS

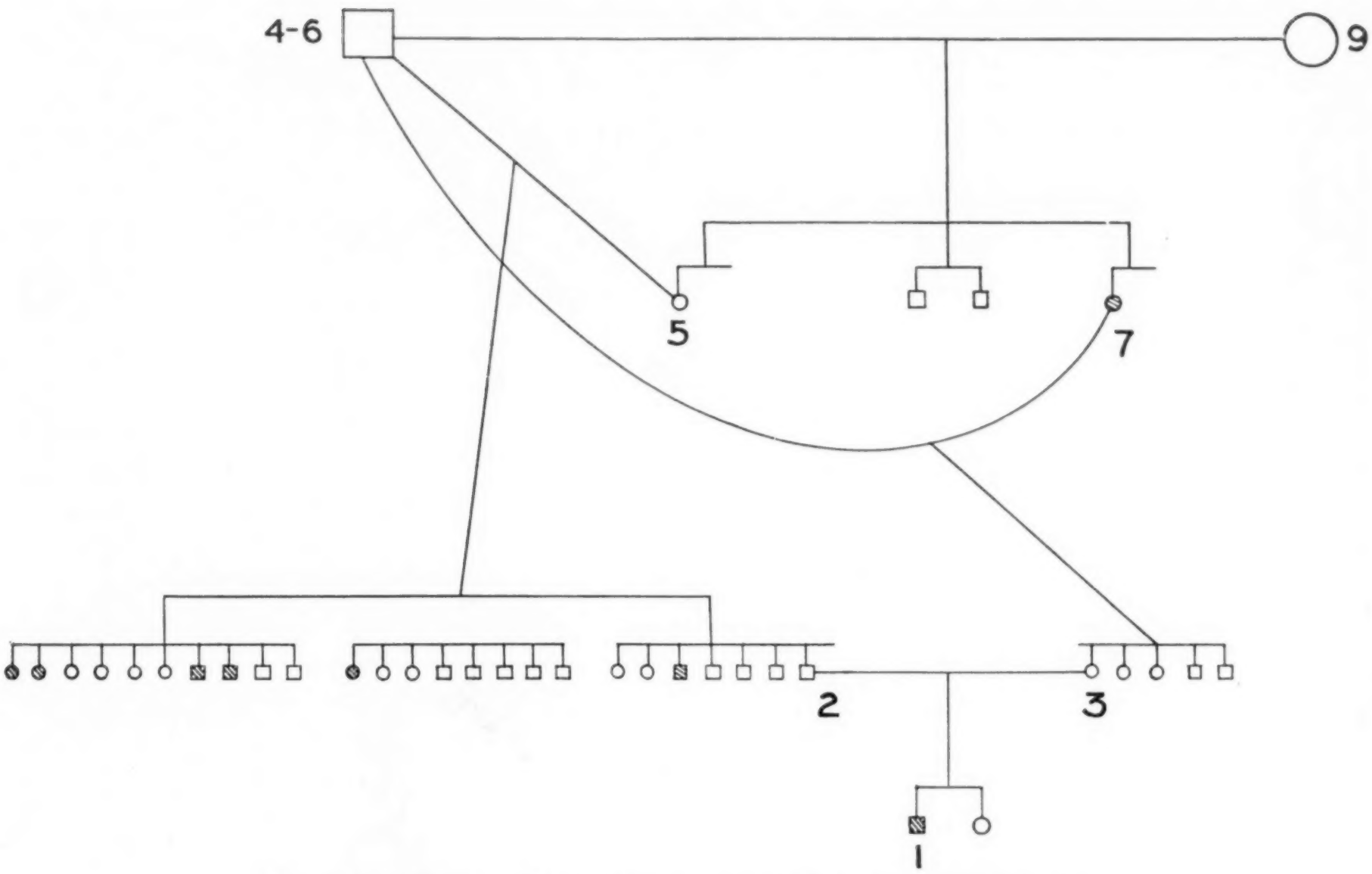
The standard of the breed calls for a white animal with pigment in only two places—eyes and nose. But many dogs carry a diluted pattern in the coat—the faint spots can be seen on the back—and many of them in addition show an outcropping of color on the head, Michael's "mark" being on and around the ear. This does not disqualify a bull terrier, but is considered a defect. The colors of the mark are black and tan, indicating that the breed was originally a tricolor one (black, white and tan) and has been steadily selected for whiteness. As a fact, it originated in a combination of white bulldog or "mastiff" (sic) and black-and-tan terrier. (Fig. 15.)

that the standard requires what may be termed a special albinism, in that there should be no pigmentation except in two places, the eyes and nose, and that pigmentation should be as nearly jet black as possible. The breed is an old one and cross breeding has been rather rare since it is heavily penalized by "faults" in the offspring.

Color spots when they do appear are often about the head and may be black, black with tan edge, or tan. In addition to the above "marks" or colored hair, there are often so-called "skin spots" which are hidden by the outer coat, and are then disregarded.

A "mark" is not a disqualification in the show ring as indicated by the marked dogs that have become champions. It is, however, generally undesirable.[1]

[1] A spotted pattern, similar to that on the dogs, is found in a great many mammals. By selection it can gradually be reduced, in which case it disappears first from the body and last of all from the head (head and ears in mice; eyes, ears, and nose in guinea-pigs; eyes in rats; ears in cattle; head in rabbit). It can never be controlled absolutely, however, because it is apparently due very largely to developmental differences, as well as to inherited factors. Hence there is no



AN ILLUSTRATION OF INTENSIVE LINEBREEDING

Above is a skeleton pedigree of the bull-terrier Michael, who figures as No. 1, at the bottom of the chart. It will be noted that he has but one grandsire, instead of two, and one great-grandsire, instead of four. Squares represent males and circles females, while the shaded symbols designate "marked" dogs. (Fig. 16.)

On the other hand the continued linebreeding of dogs which rarely or never reproduce spots may result in a too complete albinism. This would produce blue eyes or parti-colored noses—worse faults than the "mark."

The pedigree, Table 1, shows ten generations from Longmeadow Michael, whelped in 1916, to the pillars of the stud book, Old Dutch (1878), Champion Maggie May (1879), etc. With one or two exceptions all these dogs were registered either in England or America and their records are in the official stud books of the two countries. A gap exists back of Tonkinson's Sam and Malins' Rose which is presumably due to carelessness in entry or in ownership. It may be justly assumed, however, that both were of good stock in view of the success, in the show ring, of their descendants. Further, it is more than probable that the ancestors of these two dogs are to be found elsewhere in the table.

Tables 1 and 2 show the frequent interbreeding that occurred and, so far as it is now possible to ascertain, which dogs were "marked." There were unquestionably other marked dogs in many of these old litters but the marking of actual ancestors is believed to be fairly accurate.

Apart from the perpetuation of the standard coloration there was a general excellence in form as shown by the number of champions recorded and by the fact that most of the others did some winning in the show ring.

Provided the bodily form was good, and particularly if the difficult head was good, there seems to have been little hesitation in breeding to a marked

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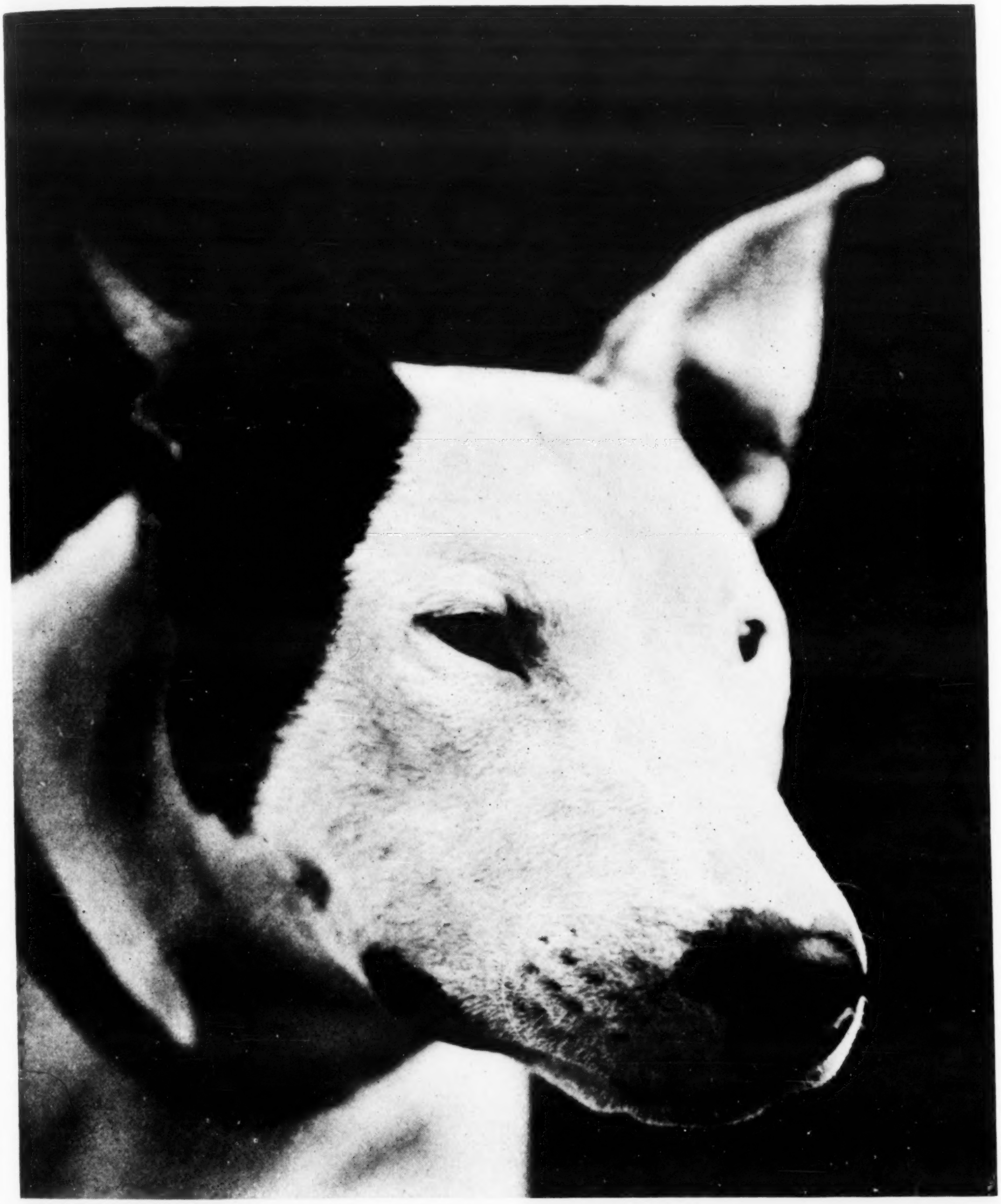
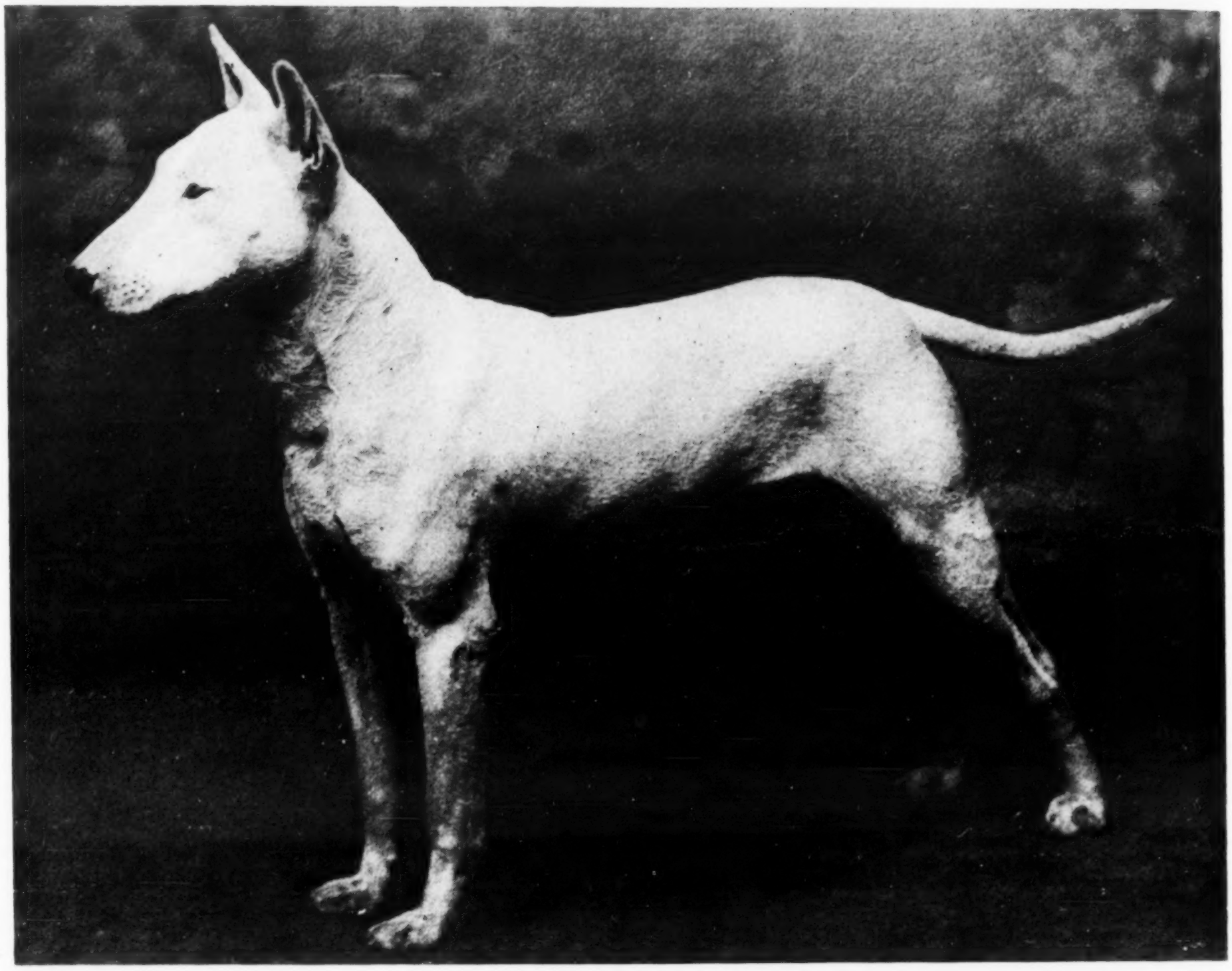
hope of establishing a strain of bull terriers which will produce no "marked" dogs: the breeder must be prepared to find in every litter some fluctuation in the amount of pigment. If the average dog has just the right amount—*i. e.*, black eyes and nose—there are sure to be others constantly appearing who will have too much—*i. e.*, marks—or too little—*i. e.*, blue eyes and white nose.—THE EDITOR.



HEAD OF LONGMEADOW MICHAEL

It should be compared with that of Old Dutch (Fig. 14), who is one of the principal ancestors of the modern breed. The standard of the breed calls for a long head with foreface filled up to the eyes, the muzzle wide yet tapering. Under jaw must be strong but not exaggerated as is that of the bulldog: the lips must be tight and the teeth meet evenly. The bull terrier's ancestry is a combination of bulldog and black-and-tan terrier; it is evident that the typical bulldog face has been largely bred out, in spite of its pronounced peculiarities. (Fig. 17.)



A GOOD TYPE OF THE MODERN BULL TERRIER

In the mind of the public, much confusion exists as to what a bull terrier is, and the name is often applied to anything that looks like a bulldog. The breed is really very well defined and established, and has lost all of the characteristic bulldog appearance and temperament. The imported champion "The Outwood Hope," shown above, is a good example of the real bull terrier of the present day. (Fig. 18.)

dog. Thus Gully the Great, a marked dog, appears thirty times in the pedigree, while Old Dutch appears twelve times although "all wrong" in legs. The latter's claim to greatness rests on his head formation which, as shown by Fig. 14, made him a desirable stud.

The writer practiced intensified line breeding on Michael who has but one grand-sire and one great-grandsire. Neither of his parents was marked although one grand-dam was marked (on the head) and his grandsire has averaged perhaps one marked dog in every ten. On the other hand the great-grand-dam Champion Iris tended to be deficient in pigmentation. Michael as shown by Fig. 15, is marked black and tan on one ear and the coat under the ear.

This litter resulted from the first breeding of the dam, to her half brother. The fact that there were but two puppies and one was marked does not in the writer's opinion, in itself, possess any definite significance. Both puppies were strong and healthy. Michael will be a heavy weight, probably 50 pounds, while Susie will resemble her dam and remain in the neighborhood of 35 pounds.

The standard permits two distinct sizes, *i. e.*, "less than 35 pounds" weight and about 17 inches high, and "over 35 pounds" and about 20 inches high. Both sizes may occur in the same litter, the leg bones of the heavy-weights being noticeably heavier even in puppies.

	Michael	*Sister Susie*
Weight at birth...	10 ounces	10 ounces
Weight 1 week...	18½ ounces	18 ounces
Weight 3 weeks...	5¾ pounds	4¾ pounds
Weight 6 weeks...	7½ pounds	6¼ pounds
Weight 4 months.	19 pounds	16½ pounds

Considering that part of the family following Patrician and Iris, both of whom were champions, all white, and over 35 lbs., the former having a general record of approximately one marked dog per litter and the latter having a tendency to under pigmentation, we have Fig. 16 to which the following description applies.

First Generation

(Michael)	Male	Fair	Heavy	Marked
(Susie)	Female	Fair	Light	

Second Generation

Female	Very good	Marked
Female		Marked
Female		
Female	Good	
Female		
Female		
Male		Marked
Male		Marked
Male		Parti-color nose
Male	Good	

Female	Good	Marked
Female	Good	
Female	Good	
Male		Parti-color nose
Male		
Male	Good	
Male	Good	
Male	Good	

Female	Good	
Female		
Male	Deaf	Marked
Male		
Male	Very good	
Male	Very good	
Male	Very good	

Female	Good	
Female		
Female		
Male	Good	
Male		

Third Generation

Female	Good		
	Rest of litter unknown		
Male			
Male			
	Rest unknown		
Female	Good		Marked
	Rest unknown		

In conclusion the writer offers this collection of data as a contribution toward what he believes would be an interesting study, *i. e.*, the genealogical tendencies of the Bull Terrier, a breed requiring extremely marked and somewhat antagonistic characteristics.

TABLE 1.—*Tabular Pedigree—Ten Generations*

Dogs	*Appearances*
Gully the Great	30
Old Prince	18
Tonkinson's Sam	18
Malins Rose	18
Gladstone	14
Florrie	14
Woodcote Wonder	14
Dulverton	14
Bromige's Fan	14
Maggie May	12
Kit	12
Old Dutch	12
Vincent Monarch	12
Rookery Boy	12
Amazement	12
Rose of Kent	12
Wallace	10
Baron	10
Old Victor	10
Old Duke of Marlborough	10
9 dogs each	8
22 dogs each	6
77 dogs each	4
114 dogs each	2
4 dogs each	1
245	1,022

TABLE 2.—*"Marked Dogs"—Ancestral Positions Indicated by Galton's System of Numbering*

(*a*) 146–182–210–246–286–290–306–338–356 414–418–434–466–484–544–564–598–618 670–674–690–752–820–854–874–800–926 930–946–1008.
(*b*) 740–742–996–998
(*c*) 741–997
(*d*) 34–50–82–114
(*e*) 7

Men and Rats Learn in the Same Way

An attempt to compare human and animal learning has been made by L. A. Pechstein (Psychol. Monogs., No. 2, 1917). He has taken the results of tests made on men and on rats recently by experimental psychologists and compared them by statistical methods. His conclusion is that "there is no royal road to mastery for the human not open to the rat."

A HIT-OR-MISS UNIVERSE

The Mechanistic View of Life, as Expounded by Jacques Loeb—Possibility That Life Is Eternal, and Never Had a Beginning—No Evidence of any Intelligent Guidance of Evolution

A MAN who lives far from architects and builders can put up a very good house or barn nowadays by buying it "K. D." The entire structure will be shipped to him "knocked down;" every part will be cut to fit, and numbered, and he has only to follow the plan which is sent him, to get each piece where it belongs and produce a finished building.

Evidently, the plan or design is essential. If the "K. D." building were picked up in the railway yards by a cyclone, carried ten miles and then dropped beside a road, its parts would hardly be expected to arrange themselves in the proper order, nail themselves together, and produce a finished building of their own accord. The building is possible only when each separate part is in its proper place with respect to the others—a fact which seems to make a plan a prerequisite.

The development of an animal from a fertilized egg has been looked on as analogous in some ways to the construction of a house. Students of genetics have established the fact that the parts of the adult are in some cases represented in the egg by factors which are distinct and separate. The tiger's stripes and his temper are, it is alleged, each represented by something in the original cell—a chemical reaction, probably, which, after a long series of reactions and interactions in the cell and in the developing embryo, ends up by producing the stripes, or the temper, as the case may be, in the tiger cub.

How do these things develop in the right order? Is it possible to conceive of such a complicated process, unless one conceives of some pre-existent design or plan in accordance with which the process of development is carried out? It might be admitted that the plant or animal is a machine; it might even be supposed that it is a machine which automatically runs itself; but can the human mind go so far as to believe that it is also a machine that manufactures itself?

Darwinism suggested this conclusion, but did not establish it. It can only be established through experimental biology.

IT WAS AN ACCIDENT

In his latest book,[1] Jacques Loeb attempts to show that a purely mechanical view of development is consistent with the facts. His explanation is (to carry the analogy a little farther) that if the cyclone picks up not one but ten thousand "K. D." houses, 9,999 of them might fall as mere heaps of kindling and nails, but that one of the number might by chance be dropped in a recognizable shape.

In addition to this, Dr. Loeb's book is a well-written brief for the mechanistic view of life in all branches of investigation. It is worth reading because, whether or not one likes a purely mechanical *philosophy*, a mechanistic *working hypothesis* is being recognized by more men of science each year as the most profitable for research. If the hypothesis used is a loose one, the investigator will never know whether his facts fit it or not. But if the hypothesis is as rigid as can be imagined, then any unconformable fact will at once be recognized as such, and the hypothesis can be enlarged to take it in.

The attempt of experimental biologists to reduce all the manifestations of life to terms of physics and chemistry

[1] The Organism as a Whole, from a physicochemical viewpoint. By Jacques Loeb, M.D., Ph.D., Sc.D., member of the Rockefeller Institute for Medical Research, New York City. Pp. 379, with 51 illustrations, price $2.50. New York, G. P. Putnam's Sons, 2 West Forty-fifth Street, 1916.

is, therefore, well worth while; but they face some formidable difficulties. Can they eliminate from heredity and development all plan and design, all "vital principle," all guidance of an intelligence? Can they reduce the immensely complicated life processes to reactions that are, in principle, as non-mystical as the evaporation of a drop of water in the sunshine, or the rising of a batch of dough which contains baking powder? In short, can all actions of so-called living matter be referred to those well-known properties which characterize so-called dead matter? Is there no essential difference between the world of living things and the world of winds, rocks and waters?

Of course, much more knowledge must be gained before any of the questions involved can be answered with confidence. Dr. Loeb attempts only to pick out a few typical problems and to show that these can be explained on a purely mechanical basis. If the mechanistic explanation proves adequate in one place, he argues, is it not right to suppose that it may not also hold good in other places? Even with this limited scope, his argument is frequently open to the criticism of passing by difficulties that to the reader may seem fatal. However, the object of this review is not to criticise his statement of the case, but merely to give a summary of that statement.

THE NATURE OF LIFE

1. First of all, is there any essential difference between living matter and dead matter? Life and death are daily accepted as antithetical, and it is generally supposed that there is some mystical quality inherent in life, which distinguishes it from the primal elements that admittedly enter into its makeup—from carbon, hydrogen, oxygen, iron, lime, and so on. Inquiry into the possible origin of life may clear up this point.

At present the perpetuation of living matter depends primarily on sugar, without which life ordinarily cannot exist. Sugar is not found in minerals, but is manufactured by plants, by the help of the red rays of sunlight, from the carbon dioxide of the air. But if the first life came from sugar, where did the sugar come from? This difficulty was surmounted a few years ago when it was discovered that some bacteria live exclusively on minerals, and can produce sugar directly from these minerals. It is no longer impossible, therefore, to conceive of organisms which could have existed on this planet at a time when it contained only minerals, no living matter; and which could from these minerals have manufactured the sugar which was necessary for the manufacture of proteins and the evolution of higher forms of life.

The first life in this world was possibly a plant similar to the modern blue-green algae. Experiments have failed to show that spontaneous generation can occur; the modern belief is that life comes only from life. It is then not safe to assume that this primordial, one-celled plant sprang into existence on the cooling globe, merely by chance, and Dr. Loeb inclines to believe that it was carried here from some other planet. "May not life after all be eternal?" he asks. If so, it is merely necessary to assume that it is passed on occasionally from one planet to another. It cannot come with meteorites, for they are too hot; but Arrhenius has suggested another means of transmission, based on the fact that for particles below a certain size the mechanical pressure produced by light waves can overcome the attractive force of gravitation.

Bodies which according to Schwarzschild would undergo the strongest influence of solar radiation must have a diameter of 0.00016 mm., supposing them to be spherical. The first question is, therefore: Are there any living seeds of such extraordinary minuteness? The reply of the botanist is that spores of many bacteria have a size of 0.0003 or 0.0002 mm., and there are no doubt much smaller germs which microscopes fail to disclose.

"We will, in the first instance, make a rough calculation of what would happen if such an organism were detached from the earth and pushed out into space by the radiation pressure of our sun. The organism would first of all have to cross the orbit of Mars, then

the orbits of the smaller and the outer planets. . . . The organism would cross the orbit of Mars after twenty days, the Jupiter orbit after eighty days, and the orbit of Neptune after fourteen months. Our nearest solar system would be reached in 9,000 years."

LIFE FROM OTHER WORLDS

There would, therefore, be no difficulty of time about transferring life from one planet of our system to another, for almost any germ could live that long. But if life is to be considered eternal, it must be capable of transmission from one solar system to another, and the shortest trip to ours is, as noted, 9,000 years. Could any known organism survive so long? Arrhenius thinks it could because of the low temperature (below—200° C.) of the space through which it would travel, where no chemical reaction could take place, and hence no decomposition or deterioration in the spores; and because of the absence of water vapor. There is even experimental evidence to support this. Bacteria were exposed for six months to liquid air, at a temperature of about —190° C. and their vitality did not seem to be affected in any way. In the cosmic space the temperature is lower than this, there is no atmosphere or water vapor and, says Dr. Loeb, "there is hence no reason why spores should lose appreciably more of their germinating power in 10,000 years than in six months. We must, therefore, admit the possibility that spores may move for an almost infinite length of time through cosmic space and yet be ready for germination when they fall upon a planet in which all the conditions for germination and development exist, *e. g.*, water, proper temperature, and the right nutritive substances dissolved in the water (inclusive of free oxygen)."

It is thus possible to imagine that living matter never had a beginning, any more than matter in general. If so, it would be idle to try to create life in the laboratory. But it is still necessary to inquire more closely, how living matter differs from dead matter. How does the growth of a germ differ from the growth of a crystal? The essential difference is that the crystal simply adds to itself by taking up material like itself, while the living cell adds to itself by building up compounds, specific for each organism, from the dilute, split products of these compounds. The one process is probably just as much explicable in chemical terms as the other. While the life process is vastly more complicated, and also differs in kind from such a simple chemical process as the manufacture of rock candy, yet it is not necessary, in Dr. Loeb's view, to regard the latter as wholly natural and the former as partly supernatural.

WHAT IS A SPECIES?

2. The second point in which Dr. Loeb attempts to substitute a simple mechanical idea for a mystical one, is in the explanation of the basis of a species. Under the microscope, the protoplasm from the cell which will produce a whale, can not be told from the protoplasm which would produce a hummingbird. Yet whale eggs always give rise to whales, and hummingbird eggs to hummingbirds. Furthermore, a species may remain constant for a long time. Walcott has found fossils of annelids, snails, crustaceans and algae in precambrian rocks in British Columbia, whose age may be as great as 200,000,000 years; yet these are so closely related to forms existing today that scientists have no difficulty in finding the genus among modern forms to which each of the fossils belongs. Wheeler has studied ants preserved in amber for 2,000,000 years, which belong to species that are still living. And the constancy of the sea invertebrate, Lingula, for at least 100,000,000 years, was recently illustrated in this Journal.[2] Moreover, the geneticist knows that species which are widely different from each other cannot be hybridized. They are "incompatible." What is it that underlies this specificity?

[2] "The Oldest Known Animal." Journal of Heredity, VIII, p. 146, April, 1917.

It has been found to be due to the fact that each species possesses proteins which differ from those of every other species; but at the same time it possesses also a genus-protein, which is shared by other species of the same genus, but differs from that of all other genera. The heredity of genus and species may be safely considered as due to the transmission of distinctive proteins; and there is some reason to think that these proteins are not carried in the chromosomes, or even in the nucleus of the germ cell. They may rather be located in the cytoplasm of the egg-cell. In any case, the specificity of life is found to be due to definite chemical causes, and not to anything mystical.

3. Fertilization of the egg and the commencement of its development are treated at some length, but the details are too technical to be summarized readily. Dr. Loeb's general conclusion is that there is nothing about these processes which need be considered outside the sphere of scientific knowledge.

PARTHENOGENESIS

The experiments on artificial parthenogenesis, which have mainly established Dr. Loeb's prestige in the eyes of the layman, are reviewed in this connection. Fertilization of the egg had been considered to consist of the union of two nuclei; but when it was shown that development could equally well be started by chemical solutions, by sticking a needle into an egg, or by injecting blood into it, biologists were forced to abandon the idea that the union of the two nuclei was the essential part. It was easy to understand that the primary function of the male cell was to furnish a stimulus—a very simple one, obviously, if the successful substitutes are considered.

Artificial parthenogenesis has been successful not only with numerous invertebrates, but with animals as high in the scale as a frog; and with at least one plant. Dr. Loeb thinks there is no inherent impossibility about such development in the warm blooded animals as well. The objection that eggs thus stimulated could not be made to develop beyond the earlier stages, has now been remedied by improved technique; Delage brought a sea urchin to maturity by artificial parthenogenesis,

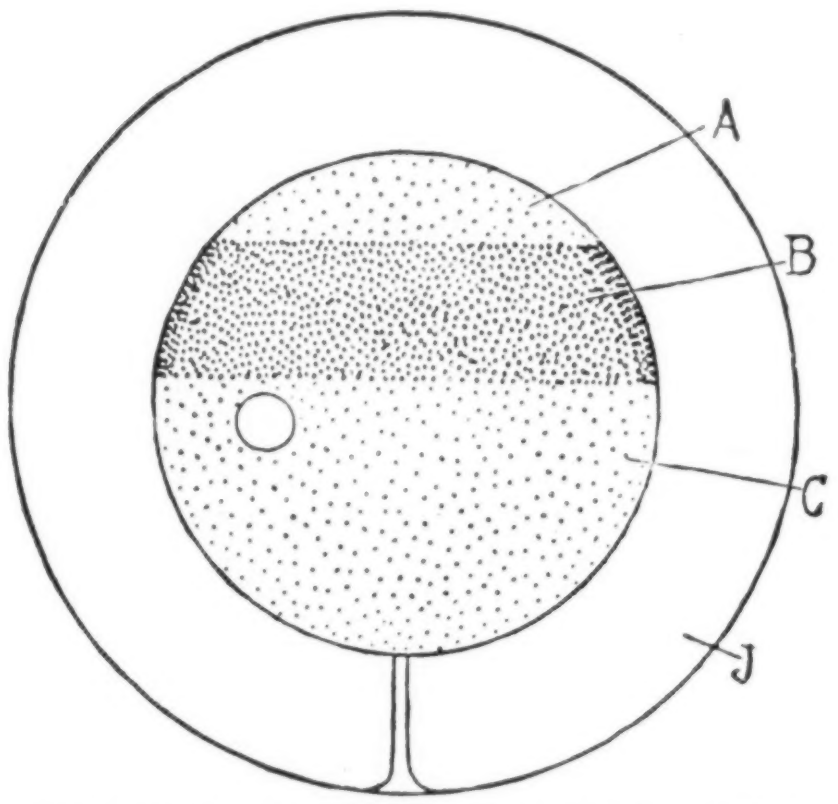
A FATHERLESS FROG

This frog was raised by Dr. Loeb from an egg-cell which had been "fertilized" merely by jabbing it with a fine needle. It is shown actual size. According to Dr. Loeb, it was no different from ordinary frogs which result from the union of two germ-cells. The spermatozoön can be entirely dispensed with in this way, but the egg-cell cannot; hence it appears to Dr. Loeb that the egg-cell produces the embryo in the rough, and that the sperm-cell adds only more or less superficial characters. (Fig. 19.)

and Loeb himself has very recently succeeded in bringing a fatherless frog to full size. The frogs, which result from the union of an egg-cell and a fine needle, can in no way be distinguished from frogs produced in the natural way by the union of an egg-cell and a sperm-cell. But while the egg-cell can thus be made to develop into an adult, without uniting with a sperm-cell, it has in no case been possible to produce development of a sperm-cell without union with an egg-cell.

From these facts two conclusions stand out prominently: (*a*) that the fundamental effect of the sperm-cell is

merely to give a stimulus to the egg-cell and cause the development of the latter; and (*b*) that the species-heredity must be carried by the egg, the sperm furnishing only Mendelian or relatively superficial inherited characters, which can be wholly dispensed with.



GROUND-PLAN OF AN EGG-CELL

It was formerly thought that the embryo was built up out of formless material in the fertilized egg-cell; and this development seemed to call for supernatural guidance. But it has now been found that even before the egg-cell is fertilized, it contains the embryo "in the rough;" and the process of development merely adds the details to the design that is already blocked out. This view makes development seem a much simpler and less mysterious process. The above diagram of a sea-urchin's egg (after Loeb) shows within the cell-wall (*J*) three well-defined zones: (*A*), a small, clear cap at one pole; (*B*), a pigmented ring; and (*C*) another unpigmented area. It has been found that each of these areas gives rise to a definite part of the embryo, as explained in the text. (Fig. 20.)

SPECIES-HEREDITY

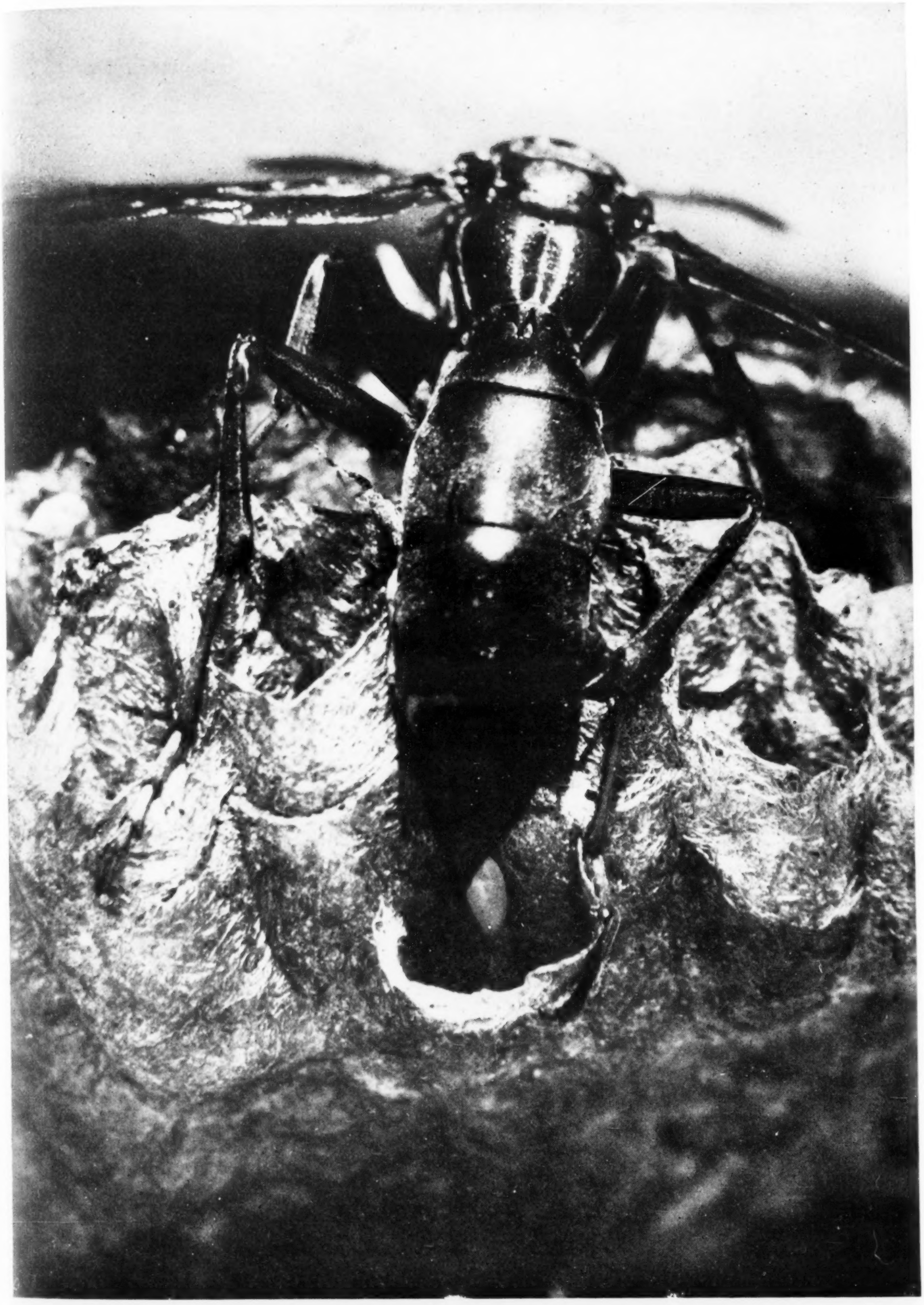
4. This opens up an aspect of heredity with which genetics is unable to deal. Study which proceeds from experimental breeding and hybridization, as genetics does, can only deal with differences in animals or plants that can be crossed; it cannot grapple with the greater problem of why one fertilized cell develops into a horse and another that is apparently not very unlike it develops into a lobster or an elm-tree. Genetics has to infer what goes on in the cell, by its observation of the characters of the *adult* organism; and, as Darbishire remarked, this is like trying to infer the nature of the works of a clock by watching the movement of its hands. Hence the embryologists have, during recent years, been able to make a contribution of fundamental importance to the study of heredity.

The most important part of it is the demonstration that the plan or design for the adult organism is laid down in the egg, even before it is fertilized. Hence there is no longer need to marvel at the intelligence with which the various factors of the egg and sperm coöperate to develop harmoniously into the adult. There is no longer need to imagine any purposive or mystical guidance of the process of development. The egg *starts* with a structure outlined in it, and development is merely a process of growth at varying rates, which develops each part of the structure in the proper way.

The existence of this structure in the unfertilized egg was discovered by the late Th. Boveri while studying sea-urchins. There is some yellowish-red pigment in the egg, and he noted that this is not equally distributed over the whole surface of the egg, but is arranged in a wide ring from the equator almost to one of the poles, as shown in Fig. 20. Thus three zones can be recognized: in the upper one, the skeleton and connective tissue originate; in the middle (pigmented) one, the intestine is built up by simple cell-division; while the third zone gives rise to the outer body-wall. Conklin has found similar structure in the unfertilized eggs of many other low animals.

FUNCTION OF THE SPERM

"The most important fact which we gather from these data is that the cytoplasm of the unfertilized egg may be considered as the embryo in the rough and that the nucleus has apparently nothing to do with this predetermination. This must raise the question suggested already in the third chapter whether it might not be possible that the cytoplasm of the eggs is the carrier of the genus or even species-heredity,



WASP LAYING AN EGG

The common paper wasp (Polistes) builds its comb under the eaves of buildings, and is a familiar object in most parts of the United States. The nest is started in the spring by a single female, who was fertilized in the preceding autumn, and lived through the winter in some sheltered crack. After she has built a few cells of paper she has made by chewing up old wood, she lays eggs in them from which functionless females or neuters hatch out. Photograph by Brown and Dawson. (Fig. 21.)

while the Mendelian heredity which is determined by the nucleus adds only the finer details to the rough block. Such a possibility exists, and if it should turn out to be true we should come to the conclusion that the unity of the organism is not due to the putting together of a number of independent Mendelian characters according to a 'pre-established plan,' but to the fact that the organism in the rough existed already in the cytoplasm of the egg before the egg was fertilized. The influence of the hereditary Mendelian factors or genes consisted only in impressing the numerous details upon the rough block and in thus determining its variety and individuality."[3]

Primitive biology supposed that the egg consisted of homogeneous material which had to be differentiated into an organism. For this supernatural task supernatural agencies seemed to be required, and it is not surprising that many biologists imagined some quasi-superhuman intelligence which presided over the development of life. But when it is found that the unfertilized egg contains the rough structure, whose creation is due to the fact that the egg is laid down a little at a time in the ovary, Dr. Loeb thinks there should be no difficulty about discarding the superstitious view and seeing merely mechanical processes.

5. If a piece of twig is cut from a willow or rose, and stuck in the ground, leaves will grow from the upper end and roots from the lower; so that the part regenerates the whole original plant. Similar effects can be produced in lower animals, and even in higher animals a part which is cut off may grow again. Is there anything mysterious about this power? Must it be supposed, with G. Wolf, that the organism has a knowledge of its own needs; or that there is some intelligent guidance of it, either inside or outside of it? On the contrary, Dr. Loeb says, "it can be shown that the organism does in this case what it is compelled to do by its physical and chemical structure." There is no miracle to be found here, unless one also finds a miracle in the fact that water runs down hill. To state the case as simply as possible, it may be said that there are certain organ-producing substances constantly in circulation in a plant or animal. As long as these circulate, they do not produce organs; but if their circulation is stopped, they start growth at the point where they collect. Thus in the geranium-cutting which is planted in sand by the gardener, there are root-producing substances and leaf-producing substances in circulation. The leaf-producing substances flow toward the apex, are stopped there, and give rise to the production of leaf-buds. The root-producing substances, which are being carried toward the base, collect at the base and start the formation of roots. The existence of these specific organ forming substances is now well demonstrated; they are now known as "internal secretions" or "hormones."

THE PROBLEM OF INSTINCTS

6. So far, it may be said, the mechanist has had relatively easy problems. The problem of development itself might even offer no embarrassment; but how can he explain the complicated instincts which make for species preservation and perpetuation?

"The idea that the organism as a whole cannot be explained from a physicochemical viewpoint rests most strongly on the existence of animal instincts and will. Many of the instinctive actions are 'purposeful,' *i. e.*, assisting to preserve the individual and the race. This again suggests 'design' and a designing 'force,' which we do not find in the realm of physics. We must remember, however, that there was a time when the same 'purposefulness' was believed to exist in the cosmos where everything seemed to turn literally and metaphorically around the earth, the abode of man. In the latter case, the anthropo- or geocentric view came to an end when it was shown that the motions of the planets were regulated by Newton's law and

[3] This view has been well criticised by L. C. Dunn: Nucleus and cytoplasm as vehicles of heredity. American Naturalist vol. li, pp. 286-301, May, 1917.

that there was no room left for the activities of a guiding power. Likewise, in the realm of instincts, when it can be shown that these instincts may be reduced to elementary physico-chemical laws the assumption of design becomes superfluous.

"If we look at the instincts purely as observers we might well get the impression that they cannot be explained in mechanistic terms. We need only consider what mysticism apparently surrounds all those instincts by which the two sexes are brought together and by which the entrance of the spermatozoön into the egg is secured; or the remarkable instincts which result in providing food and shelter for the young generation.

"We have already had occasion to record some cases of instincts which suggest the possibility of physico-chemical explanation; for example, the curious experiment of Steinach on the reversal of the sexual instincts of the male [rat] whose testes had been exchanged for ovaries. There is little doubt that in this case the sexual activities of each sex are determined by specific substances formed in the interstitial tissue of the ovary and testis. The chemical isolation of the active substances and an investigation of their action upon the various parts of the body would seem to promise further progress along this line.

"Marchal's observations on the laying of eggs by the naturally sterile worker wasps are a similar case. The fact that such workers lay eggs when the queen is removed or when they are taken away from the larvae may be considered as a manifestation of one of those wonderful instincts which form the delight of readers of Maeterlinck's romances from insect life. Imagine the social foresight of the sterile workers who when the occasion demands it 'raise' eggs to preserve the stock from extinction! And yet what really happens is that these workers, when there are no larvae, can consume the food which would otherwise have been devoured by the larvae; and some substance contained in this food induces the development of eggs in the otherwise dormant ovaries." What appeared at first sight as a mysterious social instinct is revealed as a simple and commonplace effect of nutrition.

REACTIONS TO LIGHT

"If we wish to show in an unmistakeable way the mechanistic character of instincts we must be able to reduce them to laws which are also valid in physics. That instinct, or rather that group of instincts, for which this has been accomplished is the reaction of organisms to light. The reader is familiar with the tendency of many insects to fly into the flame. It can be shown that many animals, from the lowest forms up to the fishes, are at certain stages—very often the larval stage—of their existence slaves to the light."

Numerous experiments are cited which do indeed prove conclusively that many animals react to light in a perfectly definite way. A tendency to move when stimulated by light is called heliotropism. "A most interesting example of the rôle of heliotropism in the preservation of a species is shown in the caterpillars of *Porthesia chrysorrhoea*. The butterfly lays its eggs upon a shrub. The larvae hatch late in the fall and hibernate in a nest on the shrub, as a rule not far from the ground. As soon as the temperature reaches a certain height, they leave the nest; under natural conditions, this happens in the spring when the first leaves have begun to form on the shrub. (The larvae can, however, be induced to leave the nest at any time in the winter, provided the temperature is raised sufficiently.) After leaving the nest they crawl directly upward on the shrub where they find the leaves on which they feed. Should the caterpillars move down the shrub, they would starve to death, but this they never do. What gives the caterpillar this never-failing certainty which saves its life, and for which a human being might envy the little larva? Is it a dim recollection of experiences of former generations? It can be shown that it is the light reflected from the sky which guides the animal upward. When we put these animals into a horizontal

IMMATURE WASPS IN THEIR CELLS

When a crop of neuters or workers has been produced in the wasp nest, these begin to expand the size of the nest, while the original female or queen continues to lay eggs. The young larvae, in the stage shown at the left of the photograph above, are fed by the workers; later they go through a quiet period of pupation, as shown at the right, after which they issue forth to take up the work of the colony. All these neuters (functionless females) are produced by fertilized eggs: they receive an inheritance from two parents. The fact that they are sexually functionless is apparently due to a lack of something in their food. Photograph by Brown and Dawson. (Fig. 22.)

test-tube in a room, they all crawl toward the window, or toward a lamp; the animal is positively heliotropic. It is this positive heliotropism which makes them move upward where they find their food, when the mild air of the spring calls them forth from their nest. At the top of the branch, they come in contact with a leaf, and chemical or tactile influences set the mandibles of the young caterpillar into activity. If we put these larvae into closed test-tubes which lie with their longitudinal axes at right angles to a window, they will all migrate to the window end, where they stay and starve, even if their favorite leaves are close behind them. They are slaves of the light.

"The few young leaves on top of a twig are quickly eaten by the caterpillar. The light, which saved its life by making it creep upward where it finds food, would cause it to starve could it not free itself from the bondage of positive heliotropism. The animal, after having eaten, is no longer a slave of the light, but can and does creep downward. It can be shown that a caterpillar, after having fed, loses its positive heliotropism almost completely and permanently. If we submit unfed and fed caterpillars of the same nest contained in two different test-tubes to the same artificial or natural source of light, the unfed will creep to the light and stay there until they die, while those that have eaten will pay little or no attention to the light. Their sensitiveness to light has disappeared; after having eaten they become independent of light and can creep in any direction. The restlessness which accompanies the condition of hunger makes the animal creep downward—which is the only direction open to it—where it finds new young leaves on which it can feed. The wonderful hereditary instinct, upon which the life of the animal depends, is its positive heliotropism in its unfed condition and its loss of this heliotropism after having eaten."

There is no room for mysticism in explanation of this tropism, because it can be imitated artificially, as in a wooden "dog" with eyes of selenium, which John Hays Hammond, Jr., manufactured several years ago. This was mounted on wheels, and the action of light on the selenium influenced motors attached to these wheels. The "dog" would, therefore, follow a man with a lantern, even if the man walked in circles or zigzags. It is certain that the heliotropism of the animals above described is of a similar character, sensitive areas in the eyes or on the surface of the body being stimulated by light and communicating an impulse to the muscles, directly or indirectly.

If in several critical cases the existence of highly specialized instincts can be explained on a purely mechanical basis, as above, Dr. Loeb thinks it unscientific to bring in mystical influences, of a kind not capable of investigation, to account for other instincts.

7. It is equally important, in Dr. Loeb's view, to avoid any mysticism in thinking about the relation of the environment to the organism. The very term "environment," he objects, has a vagueness that is almost mystical; if instead of this the definite parts of the environment, such as temperature, moisture, saltiness of sea water, etc., were spoken of, it would make for clearer thinking. When these different elements of the environment are tested it is found, *if disturbing influences can be avoided*, that a living organism reacts just as precisely as a thermometer.

Again, the question of adaptation to the environment leads to a lot of loose thinking. It is sometimes supposed that the environment can cause an adaptive modification of the organism, and that such a modification may even be hereditary; but there are striking cases which warn against the falseness of this explanation of the origin of characters. Heliotropism, for example, might be supposed to be due to the inheritance of the effects of light on many generations of caterpillars; but it is found that caterpillars which spend their lives under the bark of willow trees and a shellfish which spends its life in the mud, are likewise heliotropic although neither of these has ever had, so far as is known, a chance to make

use of this capacity. "We understand today why this should be so, since heliotropism depends upon the presence of photosensitive substances, and it can readily be seen that the question of use or disuse has nothing to do with the production of certain harmless chemical compounds in the body."

USELESS CAPACITIES

A more striking case is that of galvanotropism. Dr. Loeb showed long ago that many animals react in a very definite way to a galvanic current, being made to move toward one of the electrodes; yet no animal in a state of nature has ever been subjected to a continuous electric current. This capacity, then, could not possibly have been evolved through use, nor can natural selection have had anything to do wth it. It is equally a puzzle to the vitalist who thinks that every part of an animal is given to it for some purpose. "The only consistent attitude is that of the physicist who assumes that the reactions and structures of animals are consequences of the chemical and physical forces, which no more serve a purpose than those forces responsible for the solar systems. From this viewpoint it is comprehensible why utterly useless tropisms or structures should occur in animals."

A famous case for the apparent adaptation of animals to environment has been the blind cave animals. It is known that in caves blind salamanders, blind fishes and blind insects are common, while such forms are comparatively rare in the open. This fact has suggested the idea that the darkness of the cave was responsible for the degeneration of the eyes. But some species of cave-salamanders are blind, while others are not. If disuse is the cause, why are they not all blind alike? Again, a blind fish is found living in the open water, off the coast of southern California. Why is it blind, in spite of constant exposure to the light?

Recent experiments with fish have shown that blindness can be produced in more than one way: (1) when wide crosses are made, blind embryos are frequently produced; (2) the eyes fail to develop if the temperature is kept very low; and finally (3) blind fish can be produced if certain chemicals are added to the water.

The true explanation of the frequency of blind fish in caves then is fairly obvious. Animals born with defects which would handicap them in open water may survive in a cave, and if they accidentally wander into a cave, they will perpetuate themselves there. The cave is not responsible for producing the blindness, but merely for allowing a blind form to live. The idea that the cave adapts its inmates to life under cave conditions, is, therefore, a misinterpretation.

"This attitude leaves us in a quandary. The whole animated world is seemingly a symphony of adaptation. We have already mentioned the eye with its refractive media so well curved and placed that a more or less perfect image of outside objects is focussed exactly on the retina; and this in spite of the fact that lens and retina develop independently; we have mentioned and discussed the cases of instincts or automatic arrangements which are required to perpetuate life—the attraction of the two sexes and the automatic mechanisms by which egg and sperm are brought together; the maternal instincts by which the young are taken care of; and all those adaptations by which animals get their food and the suitable conditions of preservation. Can we understand all these adaptations without a belief in the heredity of acquired characters? As a matter of fact the tenacity with which some authors cling to such a belief is dictated by the idea that this is the only alternative to the supernaturalistic or vitalistic ideas. The writer is of the opinion that we do not need to depend on the assumption of the heredity of acquired characters, but that physiological chemistry is adequate for the purpose."

FORMATION OF THE EYE

The formation of the eye is a good test case. Uhlenhuth transplanted the eyes of young salamanders into different parts of their bodies where they

were no longer connected with the optic nerves. The eyes after transplantation underwent a degeneration which was followed by a complete regeneration. He showed that this regeneration took place in complete darkness and that the transplanted eyes remained normal in salamanders kept in the dark for fifteen months. Lewis has shown that if the optic cup is transplanted under the skin of a young larva into any part of the body, the skin in contact with the optic cup will form a lens. It appears then that the formation of the lens is due to some chemical substance secreted by the optic cup; that the development of the eye is quite independent of the brain; and that it is quite independent of light. It is an automatic, self-regulating process.

"Examples might be multiplied indefinitely. They all indicate that apparent morphological and instinctive adaptations are merely caused by chemical substances formed in the organism and that there is no reason for postulating the inheritance of acquired characters. We must not forget that there are just as many cases where chemical substances circulating in the body lead to indifferent or harmful results." As an example of the first type is heliotropism in animals living in the dark, and galvanotropism in all animals; an example of the second type is hereditary color-blindness in man.

It is sometimes supposed that a mystical force tends to produce harmonious organisms. As a matter of fact, all kinds of disharmonics are being constantly produced; but they do not survive and therefore we are not reminded of their possible existence. Hence cases of apparent adaptation prevail in nature.

To illustrate how many possible disharmonies there are in nature for every harmony that exists, Dr. Loeb remarks that it is possible to fertilize the eggs of practically every marine bony fish with the sperm of practically every other marine bony fish; and as fertilization takes place more or less accidentally in the water, such cross-fertilizations must be constantly occurring. If they could all develop, the 10,000 kinds of marine bony fish now in existence would give rise to 100,000,000 new forms. But experiment shows that most of these hybrids have a defective circulation, and only a fraction of 1 per cent can live. It is therefore, no exaggeration to state that the number of species existing today is only an extremely small fraction of those which can and possibly do originate, but which escape notice and disappear because they cannot live or reproduce.

From such facts, Dr. Loeb concludes that the laws of chance are sufficient to account for all the apparently purposeful adaptations. If an intelligence really were directing evolution, it would have to stand convicted of extraordinary bungling.

THE NATURE OF DEATH

8. It is an old saying that one cannot understand life unless he understands death; hence Dr. Loeb devotes his last chapter to a discussion of the death and dissolution of the organism. The dead body undergoes disintegration; hence it was natural to argue that life is that which resists this tendency to disintegration. "The older observers thought that the forces of nature determined the decay, while the vital force resisted it. This idea found its tersest expression in the definition of Bichat, that 'life is the sum total of the forces which resist death.'" But such talk is to Dr. Loeb intolerably mystical. Analyze it, and nothing definite remains. It offers no useful knowledge, it points to no processes which can be weighed, measured, or counted. "Science is not the field of definition, but of prediction and control. The problem is: first, how does it happen that as soon as respiration has ceased only for a few minutes the human body is dead, that is to say, will commence to undergo disintegration; and, second, what protects the body from this decay while respiration goes on, although temperature and moisture are such as to favor decay?"

The question recalls that problem of the older biologists: why does not the stomach digest itself? As a fact, it

THE FRONT OF A WASP'S NEST

The cells of the nest are not allowed to remain idle: as soon as one wasp emerges, the cell is cleaned out and another egg laid in it. Later in the fall the queen's supply of fertilized eggs is exhausted, and she then lays eggs which have never been fertilized. They contain no inheritance from a male parent, but represent only a mother. These unfertilized eggs develop into males who, after fertilizing the females, quickly perish. The neuters likewise perish at the beginning of cold weather, and the only members of the colony who survive are the fertilized females, who are ready in the spring to start nests of their own. Photograph by Brown and Dawson. (Fig. 23.)

does so as soon as the individual is dead, but not during life. Recent work has shown that the power of self-digestion is shared by all organs and tissues. What keeps it in check? Oxygen, probably. When the oxygen is shut off, disintegration begins; and in the higher animals this will occur if the oxygen is absent for only a few minutes. It is possible that the brain cells which control respiration are particularly delicate and sensitive, and are irreparably injured by the absence of oxygen for a short time. Therefore, suffocation causes the death of the whole body, because the heart-beats must cease after respiration does, and therefore the nutritive solution which the blood carries to all the cells is shut off and they break down. Every cell in the body of a mammal is potentially immortal, it is now believed, but they are so specialized, so dependent on each other, that the destruction of the nerve cells which control respiration quickly entails the death of all the rest.

What is commonly called "life" is to Dr. Loeb merely a chain of chemical reactions. Death is merely the breaking of the chain, the interruption of the series.

SUMMARY

9. It may now be useful to sum up the doctrine of the book in Dr. Loeb's own words.

"It is generally admitted that the individual physiological processes, such as digestion, metabolism, the production of heat or of electricity, are of a purely physicochemical character; and it is also conceded that the functions of individual organs, such as the eye or the ear, are to be analyzed from the viewpoint of the physicist. When, however, the biologist is confronted with the fact that in the organism the parts are so adapted to each other as to give rise to a harmonious whole; and that the organisms are endowed with structures and instincts calculated to prolong their life and perpetuate their race, doubts as to the adequacy of a purely physicochemical viewpoint in biology may arise. The difficulties besetting the biologist in this problem have been rather increased than diminished by the discovery of Mendelian heredity, according to which each character is transmitted independently of any other character. Since the number of Mendelian characters in each organism is large, the possibility must be faced that the organism is merely a mosaic of independent hereditary characters. If this be the case the question arises: What moulds these independent characters into a harmonious whole?

"The vitalist settles this question by assuming the existence of a pre-established design for each organism and of a guiding force or principle which directs the working out of this design. Such assumptions remove the problem of accounting for the harmonious character of the organism from the field of physics or chemistry. The theory of natural selection invokes neither design nor purpose, but it is incomplete since it disregards the physicochemical constitution of living matter about which little was known until recently.

"In this book an attempt is made to show that the unity of the organism is due to the fact that the egg (or rather its cytoplasm) is the future embryo upon which the Mendelian factors in the chromosomes can impress only individual characteristics, probably by giving rise to special hormones and enzymes. We can cause an egg to develop into an organism without a spermatozoön, but apparently we cannot make a spermatozoön develop into an organism without the cytoplasm of an egg, although sperm and egg nucleus transmit equally the Mendelian characters. The conception that the cytoplasm of the egg is already the embryo in the rough may be of importance also for the problem of evolution since it suggests the possibility that the genus- and species-heredity are determined by the cytoplasm of the egg, while the Mendelian hereditary characters cannot contribute at all or only to a limited extent to the formation of new species. Such an idea is supported by the work on immunity, which shows that genus- and probably species-specificity are due to specific proteins, while the

Mendelian characters may be determined by hormones which need neither be proteins nor specific or by enzymes which also need not be specific for the species of genus. Such a conception would remove the difficulties which the work on Mendelian heredity has seemingly created not only for the problem of evolution but also for the problém of the harmonious character of the organism as a whole."

THE SURVIVAL OF THE FITTEST

Above all, the rôle of blind chance must be emphasized. Harmonious combinations finally are evolved, because an immense number of combinations has been tried and the unsuccessful ones rejected. Many failures are destroyed, even today, in the struggle for existence; and the multiplication of creations has been going on for perhaps a billion years. In each generation many new combinations were produced by chance; most of them were incapable of living but the occasional one that represented better adaptation to its surroundings lived and multiplied.

10. No one would claim that science today can offer a mechanical explanation of all the problems of life. But in the mechanist's view, so many seemingly metaphysical problems have yielded to a physicochemical explanation, that there is no justification for denying that all the rest can probably be explained in the same way, as scientific research proceeds. The idea that "living" matter contains some "vital principle" which makes it different in kind from "dead" matter is to him worthless. The idea that the development of the embryo is controlled by some invisible guiding force, some mysterious influence of an unascertainable nature, following a mystically preestablished plan or design, is for him obsolete. He sees no room in the body for any soul, no room in the world for any directing force except the kind of chance that governs the fall of dice from a box. The "mystery of life" is for him a mystery in the sense that it is so complicated as to be difficult of investigation. In any other sense, he would admit no more mystery in life than in the effervescence of a seidlitz powder.

A. G. A. Publications Wanted

Many of the publications of the American Genetic Association are out of print, and it is impossible for members who desire to complete their files, or to obtain complete sets, to do so. The following numbers of the association's magazine are particularly in demand for this purpose:

American Breeders' Magazine, Vol. iii, No. 4.

Journal of Heredity, Vol. v (1914), No. 1.

Journal of Heredity, Vol. vii (1916), Nos. 1, 2, and 4.

The secretary of the association will be glad to receive copies of any of the above, in good condition. He will exchange for any one of them a copy of Vol. vi, Proceedings of the American Breeders' Association (a description of which will be found on the inside back cover of this issue), or will credit a member with three months' extension of his membership, for each one of the above magazines returned.

The Prevention of Crime

Expenses for crime in Ohio increased six and one-half times as rapidly as the population in eight years, 1906–1914, says Dr. Thomas H. Haines in Bulletin No. 5 of the Bureau of Juvenile Research. The best way to remedy this is to remove the causes of crime, and the best way to get at the causes is to study the young offenders. Hence Ohio established a State clinic for all convicted young offenders, and before any young delinquent is sentenced, a radical search for the causes of his delinquency is made. This Bureau, of which Dr. Haines is clinical director, has taken an enlightened stand in eugenics.

WHEAT-RYE HYBRIDS

EDGAR A. MCFADDEN, *Brookings, S. D.*

I WAS greatly interested in the article, "Carman's Wheat-Rye Hybrids," by C. E. Leighty, which appeared in the September, 1916, issue of this magazine. Mr. Carman's experience with wheat-rye hybrids as noted in the article referred to is very similar in many respects to an experiment conducted by myself during the past three years.

During the summer of 1915, having in mind the production of a hardy winter wheat that would withstand the severe winters of the Dakotas, I attempted to produce some hybrids between wheat and rye. At that time I knew nothing of Mr. Carman's experiments with wheat-rye hybrids, but the fact that rye was very winter-hardy and a close relative of wheat led me to believe that a cross between these two cereals might result in a variety having the hardiness of rye combined with the milling qualities and other desirable characteristics of wheat.

The varieties chosen for hybridization were Turkey winter wheat and Swedish rye, two of the hardiest varieties of their respective classes. The flowers on nine of the wheat heads were carefully emasculated, after which pollen from the rye was dusted upon the stigmas. The heads were then wrapped in tissue paper to protect them from foreign pollen. As a result of this treatment nine of the flowers pollinated set seed, an average of one seed for each head, none of the heads setting more than three seeds. Most of these seeds were badly shrunken and distorted in appearance, and upon being planted that fall, only two out of the nine grew. These two supposedly hybrid plants came through the winter in perfect condition but upon heading out the following summer, one of them proved to be a typical wheat plant, probably the result of self-fertilization. The other plant was a true hybrid, possessing some of the characteristics of each parent, but could easily be mistaken for a pure wheat plant.

The most noteworthy differences between the hybrid plant and its parents were in the number of spikelets on the normal spikes, and the length of the culms. The female parent (wheat) has, normally, eight or nine pairs of spikelets per spike, while the male parent (rye) has from sixteen to twenty. The length of the culms in wheat is also considerably less than that of the rye. The hybrid plant contained fourteen to sixteen paired spikelets per spike with culms intermediate in length between the two parents. It was uncommonly thrifty in appearance, and produced twenty-five vigorous culms that developed heads, and also several tillers that did not develop fully. The first spikes to appear produced no seed, the cause of which was revealed by the microscope which showed that, although anthers were present, yet no normal pollen grains were developed. The flowers on a few of the later spikes were hand-pollinated with pollen from Kharkov winter wheat, as a result of which three seeds were produced. These seeds were planted last fall, and two of them grew and produced vigorous plants neither of which survived the past winter. If hardiness is assumed to be a recessive unit character, then one could not expect these hybrid plants to survive a winter like the past in which nearly all unprotected wheat plants succumbed. Working on this assumption, hybridization work along the same line will be continued this summer on a larger scale, and the F_1 and F_2 plants carried through the winter in the greenhouse.

RYE WHEAT × RYE WHEAT

A WHEAT-RYE HYBRID AND ITS PARENTS

The cross between wheat and rye is believed to promise the production of a grain that would be valuable for its hardiness: but it is an extremely difficult cross to make, and most attempts fail. Photograph ¾ natural size. (Fig. 24.)

Genetics Literature

THE annual reports of the AMERICAN BREEDERS' ASSOCIATION, published in seven volumes, form the most valuable collection of material for students of genetics which has been published in the United States. Most of them are out of print and are becoming expensive. All of them are nearly indispensable to libraries, institutions and students of plant and animal breeding, heredity, variation, eugenics, or genetics in general.

The Association still has on hand a limited number of copies of three of these reports, which it offers for sale.

Vol. VI, Proceedings A. B. A. (1910), contains 465 pages. Illustrated. It includes 80 papers on general genetic subjects, and among the contributors are practically all the leaders in this study in the United States. **Issued at $2, now offered for $1.**

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